AGRICULTURE

ANIMAL HUSBANDRY

by

WM. P. BROOKS

The HOME CORRESPONDENCE SCHOOL

VINCENT-L-KAIN

42

PHOTO-CHROMO. ENG. CO., PHILA.

AYRSHIRE COW DUCHESS OF SMITHFIELD, No. 4256.

PAINTED BY J. W. HILLS,
FROM PHOTOGRAPH.

Agriculture

VOL. III

ANIMAL HUSBANDRY, *including* THE BREEDS OF LIVE STOCK, THE GENERAL PRINCIPLES *of* BREEDING, FEEDING ANIMALS; *including Discussion of Ensilage,* DAIRY MANAGEMENT *on the* FARM, *and* POULTRY FARMING

. . *By* . .

WILLIAM P. BROOKS, Ph.D.

Professor of Agriculture, Massachusetts Agricultural College and Agriculturist, Hatch Experiment Station.

The HOME CORRESPONDENCE SCHOOL

THE KING-RICHARDSON CO., *Proprietors*

SPRINGFIELD, MASSACHUSETTS

1901

CONTENTS

ILLUSTRATIONS

Preface

This volume is paragraphed consecutively with the two earlier volumes in this series and will be found most useful in connection with them. Numerous references are made to subjects treated in the earlier volumes. The treatment of certain subjects, particularly the "Principles and Practice of Feeding" and "Dairy Husbandry," in this volume, does not include a particular consideration of the several crops of home production. Information concerning them and the methods to be used in producing them are given in Volume II.

In this volume will be found a brief account of all the breeds of live stock and poultry that have any prominence in the United States. The account of each, though short, has been prepared with much care and with a view to enabling the farmer intelligently to judge whether a breed will be found suited to his requirements. It can hardly be hoped that the particular friends of all the various breeds will be pleased with the views expressed. The author has endeavored, however, to make no statement not well established and to express a view only in cases where he believes he has a good basis for judgment. He is fully aware that each breed has a place and a special value somewhere; and has sought only to help those for whom this book is written to form an intelligent judgment.

The principles underlying breeding are concisely set forth and

brief practical hints and suggestions are given as to general management.

Feeding is treated at some length. An effort is made to make the more important scientific principles and their application clear. The method of making up desirable combinations of food stuffs has been made as simple as possible. A large number of mixtures which have been used with good results or which are advised by distinguished authorities are given.

The essentials for the production of milk and cream of good quality are carefully presented, and the best methods of handling and marketing these articles are briefly pointed out. The necessity of good cows for profit, and the means of ascertaining which are the good cows in the herd, are explained.

The hints given under poultry farming will, it is hoped, make clear some of the more important essentials to success.

It has, of course, been impossible to treat the several subjects taken up in this volume exhaustively. Volumes are written upon each of them, and to these special works the student must refer for fuller treatment.

In the preparation of this volume the author has consulted many special works, official reports, and bulletins. He acknowledges his especial indebtedness to the following: The Breeds of Dairy Cattle, Alvord; Holstein-Friesian Cattle, Hoxie; Farm Live Stock of Great Britain, Wallace; Horses, Cattle, Sheep, and Swine, Curtis; Stock Breeding, Miles; Principles and Practice of Stock Feeding, Hills; Feeding Animals, Jordan; Bulletins of the Hatch Experiment Station by Lindsey; Milk and its Products, Wing; and Poultrycraft, Robinson.

The author further desires to express his most sincere thanks to his colleagues, Prof. F. S. Cooley, Dr. J. B. Lindsey, and H. M. Thomson, for reading manuscript and for valuable suggestions and

criticisms. Especial thanks are due to the many who have so courteously allowed the reproduction of illustrations. Full credit, it is believed, is given for all the illustrations not especially made for this volume.

Wm. P. Brooks

Massachusetts Agricultural College,
AMHERST, Mass., July 16, 1901.

AGRICULTURE

VOL. III

ANIMAL HUSBANDRY, INCLUDING THE BREEDS OF LIVE STOCK.

LXXIX. ANIMAL HUSBANDRY.

557. *What animal husbandry is* — Animal husbandry in its broadest sense includes any branch of agriculture which has for its object the production of animals or animal products of any kind. It may, therefore, include apiculture or the raising of bees, fish culture, oyster culture, etc., as well as those branches of industry connected with the production of cattle, horses, sheep, swine, and poultry, or products from any of these animals. The subject will be here considered only in its more restricted sense and will include only topics connected with the domestic animals and fowls just named.

Animal husbandry thus restricted will be considered under three subdivisions: stock farming, which is that branch of farming having for its object the production of the larger domestic animals for sale or use; dairy husbandry, which has for its object the production of milk or milk products; and poultry farming, which has for its objects the production of ducks, geese, turkeys, and chickens, or eggs.

LXXX. STOCK FARMING.

558. *Subjects to be considered under stock farming* — Under stock farming, as above defined, we shall have to consider : —

1st. The breeds of live stock.

2d. Stock breeding.

3d. The principles and practice of feeding.

LXXXI. BREEDS OF LIVE STOCK.

559. *What a breed is* — A subdivision of any species in the animal kingdom is called a breed when all the individuals belonging to it show a high degree of uniformity in all important characteristics, and when the peculiarities displayed by the different individuals have become so well fixed that they are transmitted from parent to offspring, from generation to generation, with a high degree of certainty and uniformity. The differences which distinguish breeds of domestic animals are for the most part the result of artificial conditions produced by man, though to some extent these distinctions are the result of environment or peculiarities of location, soil, food, and climate. There is much difference in the various breeds in respect to the degree of uniformity existing between the different individuals, as also in regard to the certainty with which characteristics are transmitted to offspring. As a general rule, the longer a breed has been in existence, provided it has been in skillful hands, the more firmly have its characteristics become fixed and the more certainly are they transmitted.

LXXXII. NEAT CATTLE (*Bos taurus*).

560. *Origin of domestic cattle* — All the various breeds of domestic cattle are probably descended from one parent stock. We find very wide variations ; but these can be accounted for by the widely different conditions under which the cattle, in different localities, and in the hands of different breeders, have been kept. Fully one hundred breeds of cattle are now known to exist, but comparatively few of these have any importance in the United States. Only such as are found in this country will be here con-

sidered. All the breeds of cattle found in the United States have either been brought to us from England or from some part of the continent of Europe, or have been produced in this country (with very slight modifications in most cases) from stock which originally came fron those countries.

561. *The breeds of cattle classified* — Some writers put all the breeds which have any importance in the United States into two classes, viz., dairy breeds and beef breeds. There are, however, some breeds which show a high degree of excellence both for dairy purposes and for beef; other breeds in which certain families or certain strains of blood show a very high degree of excellence for one purpose; while other families or other strains of blood are equally noted for excellence in the other direction. It seems desirable, therefore, to make a third class. The different breeds which we are to consider, then, will be included under three subdivisions: dairy breeds, including all those breeds that are kept primarily for the production of milk, butter, or cheese; beef breeds, which are kept primarily for the production of beef; and dual purpose breeds, which may be kept for both purposes. Certain of the breeds which are to be considered possess characteristics which render them especially fitted for work; but working oxen are now so little used in most parts of the United States that a special class will not be made for working breeds. In considering the different breeds, however, the characteristics as regards the production of working animals will be stated where important.

562. *Parts of the animal named* — In order that what is to be said concerning the characteristics of the different breeds may be clearly understood, it is necessary to have definite names for the different portions of the body which are to be considered. There is now general agreement in the naming of the different points in the external anatomy of cattle, and a diagram giving the names in general use is herewith presented.

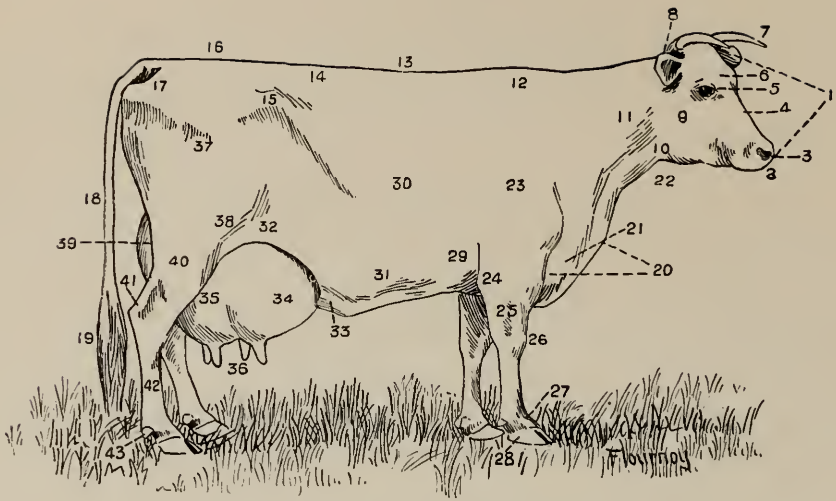


FIG. 172 DIAGRAM OF COW, SHOWING POINTS.

1. Head.
2. Muzzle.
3. Nostril.
4. Face.
5. Eye.
6. Forehead.
7. Horn.
8. Ear.
9. Cheek.
10. Throat.
11. Neck.
12. Withers.
13. Back.
14. Loins.
15. Hip bone.
16. Pelvic arch.
17. Rump.
18. Tail.
19. Switch.
20. Chest.
21. Brisket.
22. Dewlap.
23. Shoulder.
24. Elbow.
25. Forearm.
26. Knee.
27. Ankle.
28. Hoof.
29. Heart girth.
30. Side or barrel.
31. Belly.
32. Flank.
33. Milk vein.
34. Fore udder.
35. Hind udder.
36. Teats.
37. Quarter.
38. Stifle.
39. Twist.
40. Leg or gaskin.
41. Hock.
42. Shank.
43. Dew claw.

LXXXIII. DAIRY BREEDS.

563. *Important dairy breeds named* — The only distinctly dairy breeds of cattle which have any considerable importance in the United States are the Jersey, Guernsey, Ayrshire, Holstein-Friesian, Belted Dutch, and Brown Swiss.

564. *The ideal dairy type* — All the different dairy breeds show certain peculiarities in common. While differing to a considerable extent in minor points, the various breeds should all closely approach a certain type which we may call the ideal type. An effort will be made at the outset to give a

clear idea as to what this ideal dairy type is. With the dairy type clearly understood and its peculiarities well fixed in mind, the essential points concerning the different breeds can be quite briefly stated. The frontispiece shows an animal combining in remarkable degree most of the characteristics of this ideal dairy type. This cut was made from a photograph of a celebrated dairy cow. Concerning this animal Major H. E. Alvord, chief of the dairy division, United States Department of Agriculture, makes the following statements * : —

"The colored plate (frontispiece) is presented as an excellent example of a fine dairy cow. This animal is the Duchess of Smithfield 4256, American Ayrshire Record. She is descended in the seventh generation from stock imported from Scotland. The shape of the head, horn, and udder is not typical of the Ayrshire, although she is a noted cow of that breed. She was dropped in Rhode Island in 1876, and always owned in New England. In 1885, when 8 years old, she won the first prize of the Ayrshire Breeders' Association, in an official test of seven days, by a record of 464 pounds of milk, which produced 19 pounds 6 ounces of butter. She calved in March and the test was made in June. Her udder measured 68 inches in circumference during this test. Her weight was 1,128 pounds, and she gave during one full year 10,748 pounds (or 1,242 gallons) of milk. Her color was a deep, rich red, with white in about equal parts. This cow belongs to what is known as the "Douglas family" of Ayrshires. She was a great winner of prizes herself at noted exhibitions, and her descendants of the first and second generations have been equally successful. They have also made records for milk and butter production which entitle them to the highest honors as dairy sires and dairy cows. Among those sired by sons of Duchess of Smithfield was one which gave 12,172 pounds of milk in a year at the Vermont Agricultural Experiment Station, and several which have butter records ranging from 400 to 607 pounds in a year."

The student is advised to make continual reference to this portrait in connection with the description of the dairy ideal which follows : —

---

* "Breeds of Dairy Cattle," Bul. 128, B. A. I.; U. S. D. A.

Head — Small, lean, and bony, with large muzzle and mouth. The nose and face should be free from fleshiness.

Eye — Full, large, lively in its expression but at the same time mild, clear, and bright. The whole expression of the face and eye should be motherly.

Forehead — May be either straight or dishing, but the latter gives a more well-bred appearance.

Ear — Thin, large, active, and for most breeds should be of an orange color within.

Neck — Should be rather thin, especially near the head, and long. It should be free in most breeds from loose, pendent skin.

Horns — Should be of moderate size.

Shoulders — The animal at the shoulders may be from two to four inches lower than at the hips. The shoulders themselves should be thin, especially at the top, lean, and bony.

Chest — Should be deep, *i. e.*, it should have a large measurement from top to bottom. It is less broad and roomy than in beef breeds. The section through the animal behind the shoulders should have an elliptical outline. Too great thinness behind the shoulders is, however, a mark of a weak constitution.

Back — Should be rather long and rugged. The vertebræ of the backbone should be rather wide apart so that the fingers may be pressed down between the points in the ridge of the back. This is only one feature of the general looseness of structure which is looked for in the dairy type, as contrasted with the close, compact structure which is desirable in the beef type.

Loins — Should be fairly broad. The hip bones rather high and well apart. The bones, moreover, are often rather farther forward than in the beef type. This gives a long and strong hind quarter.

Thighs — The thighs should be thin, especially on the inside, in order to give room for a large udder.

Flank — The flank is well up, and rather thin.

Legs — The legs should be rather short and the hind legs may be rather

crooked. The bones of the legs should be moderately fine. The fore legs are comparatively near together, the hind legs wide apart.

Tail—The tail should be long and fine, with a long switch. A long tail is believed to indicate that the vertebræ of the backbone are somewhat loosely connected, which, as has been pointed out, is considered highly desirable.

The general outline—When looked at from the side, the general outline should be that of a wedge, the upper line or line of the backbone and the lower line or the line of the belly approaching each other from behind. When looked at from behind or from above, the animal should also present a wedge shape, the lines of the wedge approaching each other from rear to front. The dairy cow, therefore, shows a double wedge. The ribs, to harmonize with this general wedge shape, are rather flat immediately behind the shoulders. At this point they do not spring out very widely but, toward the posterior part of the animal, the ribs spring out from the backbone more and more broadly in order to give room for large internal organs,—"for a big workshop."

The udder—The udder should not be very pendent but should obtain capacity by breadth, being wide from side to side, extending well forward, well backward also, and high up between the thighs. It should be broadly and firmly attached to the abdomen. The skin of the udder should be thin and delicate. The udder should be well filled out at the bottom between the teats, and the latter should be wide apart, squarely placed, and of good size.

The veins leading from the udder forward, just beneath the skin of the belly, should be large, tortuous, and rapidly branching. They should pass in through the walls of the abdomen through large openings. These veins do not, however, become fully developed until the cow reaches maturity. They are the passages through which the blood returns from the udder to the heart and, since a large amount of blood passing through the udder is essential to the production of a large amount of milk, the development of these veins in a mature cow is a point of much importance.

In general appearance the dairy cow is somewhat loose and angular as

compared with the beef type. An animal of this type is not as pleasing to the eye as one which is more compact, smoother, and plumper in general appearance, but it should be remembered that "handsome is what handsome does," and that cows with these peculiarities will do "handsomely." If the effort be made to produce an animal of smoother outline, more compact structure, it will be found that at the same time the capacity of the cow as a dairy animal is inevitably injured.

The skin — The skin should be moderately thin, flexible, and elastic, the hair soft and fine. A skin which is too thin or papery indicates lack of constitution. The skin of the dairy cow, however, should be somewhat thinner than that of animals of the beef breeds. When the animal is in good condition, the skin will move somewhat freely beneath the outspread hand and it can be rather easily raised between the thumb and finger over the ribs.

According to Hoard, a large navel is one of the most certain indications of strong constitution and he insists that, since strong constitution is essential to large production, this is an exceedingly important point to be noted in selecting a dairy cow.

565. *Scale of points adopted by the Massachusetts State Board of Agriculture* — The Massachusetts State Board of Agriculture in 1896, after careful consideration and consultation with some of the most noted dairy specialists in the United States, adopted a general scale of points to be used in judging dairy cows, not belonging to any of the recognized pure breeds, for each of which there is such a scale of points adopted by the association of men concerned in their breeding. This general scale of points is herewith presented, for it expresses very briefly the most essential points to be looked for in a dairy animal.

	No. of Points.
Head, not too large, lean, bony, face slightly dished, broad between the eyes, not too wide between the base of horns, nostrils large, ears shapely, mouth good form, lips not too thin	5
Eyes, full and placid, expressive, intelligent	3
Neck, thin, rather long, well cut at the throttle, not heavy at shoulders	4
Back, not too straight, spinal column standing out well above body, vertebræ open, loosely connected	4
Loins, broad, point of hips prominent, pelvic arch pronounced	4

	No. of Points.
Barrel, long, double wedge in outline, broad and deep at flank, lung capacity ample, walls of abdomen strong and of medium good thickness....................	8
Hips, wide apart, rump long and tapering, free from meatiness	8
Legs and brisket: legs short and strong, thin and open at shoulders ; brisket thin and light ; thighs thin and flat on the inside....................................	6
Tail, fine, long, with good switch, hair fine in quality..........................	2
Skin and hair, velvety, pliable, soft and yellow skin, inside of ears yellow ; hair fine and soft..	6
Fore udder, full, extending well forward, large surface attachment to body and with some substance in structure	10
Hind udder, full in form, extending well up behind, allowing good breadth and ample room for distention...	10
Teats, good and uniform in size, even in structure, set squarely at the four corners of the udder..	10
Milk veins, prominent, extending well forward and crooked in their course..........	4
Disposition, quiet, intelligent, submissive yet nervous..........................	6
Substance: general appearance of eye, ear, head, hair, skin, and promise of long production..	10
	100

566. *Jersey cattle* — The Jersey, which is one of the most important of the breeds of dairy cattle, was originated on the island of Jersey. This island formerly belonged to France, from which it is distant only about thirteen miles. It is about eleven miles long and less than six miles in width. The northern and western coasts are bold and rocky, and here the island has considerable elevation above the sea level. From these coasts it slopes gradually to the south. The climate is peculiarly mild and uniform. The cattle of Jersey are believed to have come originally from Normandy and Brittany. Early in the eighteenth century measures were taken to prevent outside cattle being brought to the island, and in 1779 a law was passed prohibiting, under heavy penalties, the landing upon the island of any living animals of the ox family. This law has been rigidly enforced. Jerseys have, accordingly, been pure bred for a very long period of time and they show a high degree of uniformity in most important respects. The farms in the island of Jersey are small, varying in size, for the most part, from about three to thirty acres. The cattle are seldom kept in herds numbering more than twelve. The value of the land is so great that extensive pastures cannot exist ; and from very early times it has been the

usual practice to tether the animals whenever they are turned out for grazing. They are always led and never driven, and the work of caring for them is done mostly by women. The climate is so mild that the animals remain out of doors the greater part of the year. They are often milked in the fields. It is said that they are fed comparatively little grain. Roots are supplied in liberal amounts, the parsnip more largely than any other. The Jersey is a rather small breed of cattle, the cows varying in weight from

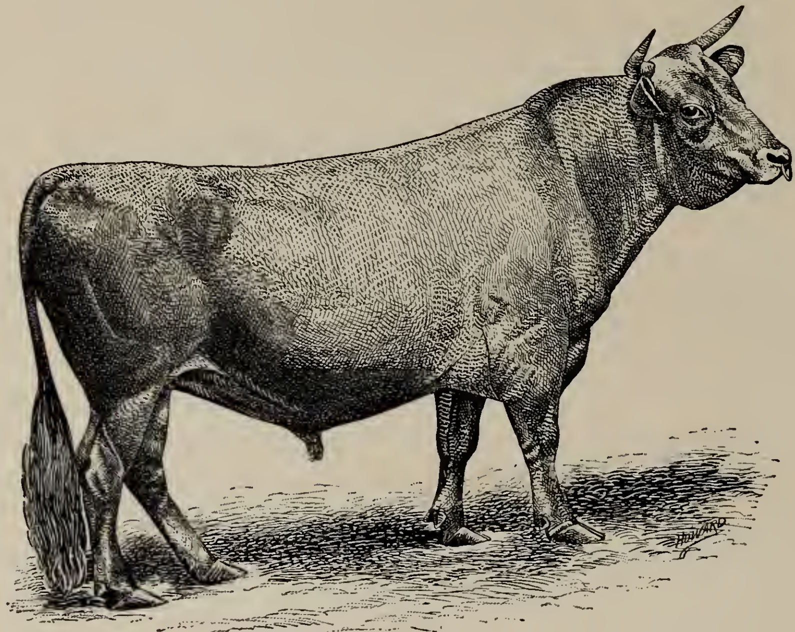


FIG. 173. JERSEY BULL, PEDRO 3187.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

about 700 to 1,000 pounds; bulls from 1,200 to 1,800 pounds. The tendency in the United States is to breed for larger size than in their native country. In color the Jersey shows considerable variation. Solid colors are generally preferred in the United States, but pure bred Jerseys may show any of the following colors: all shades of brown to deep black, various shades of yellow, fawn and tan, to creamy white; mouse color or squirrel gray is also not uncommon, while occasionally light red and brindle animals

are met with. With all these colors more or less white may be found in large or small patches on any part of the animal. Bulls are in general darker in color than the cows. The color about the head is almost invariably darker than on the other parts of the body, and around the muzzle there is a characteristic ring of light colored hair and skin which, as has been well said, "gives the animal an appearance as if she has just dipped her nose into meal." The nose and tongue of the Jersey may be either black or light, the darker color being generally preferred. The Jersey cow usually approaches the dairy ideal very closely, though the udder is not infrequently

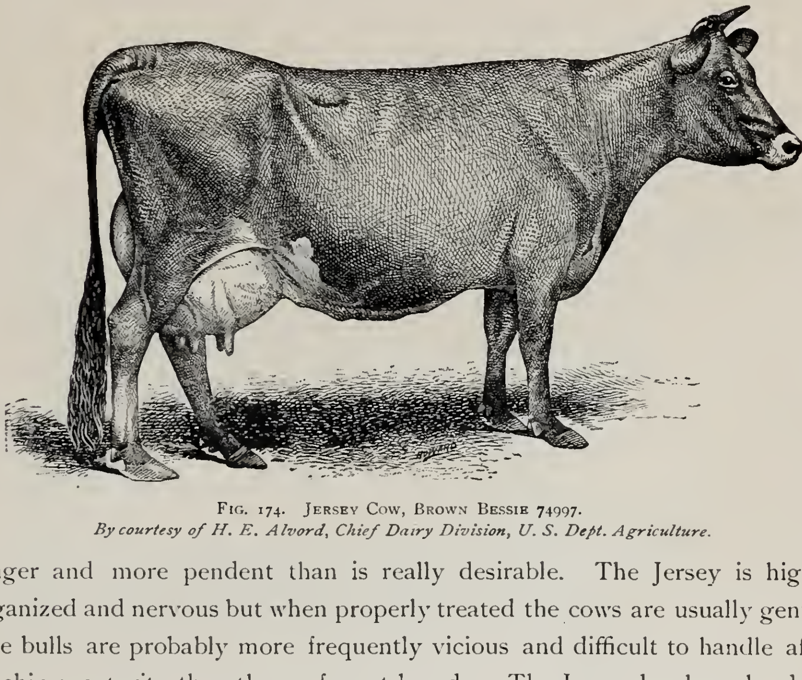


FIG. 174. JERSEY COW, BROWN BESSIE 74997.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

longer and more pendent than is really desirable. The Jersey is highly organized and nervous but when properly treated the cows are usually gentle. The bulls are probably more frequently vicious and difficult to handle after reaching maturity than those of most breeds. The Jersey has been bred for generations almost exclusively for production of milk rich in butter fat. The percentage of butter fat in the milk averages higher than for any other breed except possibly the Guernsey ; and the fat globule is of large size and of a deep yellow color. The cream separates from Jersey milk more quickly and more perfectly when set than from the milk of most breeds. This rapid

and quick separation is due to the large size of the butter globule. The usual percentage of butter fat in Jersey milk is from 4 to 5, though not infrequently it is somewhat higher. The Jersey cow is preëminently a butter specialist. In this country she is somewhat larger than in her native island and gives a rather greater quantity of milk. Many individuals have produced 600 or more pounds of butter within a year and a few individuals have made 1,000 or more pounds. Good herds may be counted upon to produce an average of 300 or more pounds of butter for every milking animal yearly. The butter produced from Jersey milk has an enviable reputation for quality. It is firm, of good color and good flavor if well made. The natural milk of cows of this breed is so rich that when used for infants it usually needs dilution. It is often too rich even for the best success in rearing calves of the breed. Concerning the feeding and productive capacity of this breed, Alvord makes the following statement: —

"Jerseys are heavy feeders and have great capacity for assimilating and then turning to profit all kinds of cattle forage. As a rule they will bear rich feeding and forcing for long periods uncommonly well. In the good animals, all the extra food is converted into milk. They do not fatten readily. The Jersey cow is essentially a machine for producing milk — butter-making milk — and may be considered worthless when she ceases to give milk. The owner should depend for profit solely upon the produce of the cow while she is alive. Yet Jersey steers and an occasional non-breeding female have been found to take on flesh at a profit and make small butchers' beasts, with fine grained, high flavored flesh, very rich in color."

The animals of this breed transmit all important characteristics with a high degree of certainty, and the bulls are among the most valuable which can be used for the improvement of the dairy herd, on account of the strong impress made upon the offspring. The cuts show two of the most noted individuals of the breed. The bull, Pedro, was a son of Eurotas, a cow with a record of 778 pounds of butter in a year without forced feeding. His weight was 1,760 pounds at the time the photograph from which the cut was made was taken. When young this animal was sold for $10,000, and proved a bargain at that price. He was used for breeding until almost

nineteen years of age. The cow is Brown Bessie, famous as the champion butter cow in the dairy tests at the Columbian Exposition, 1893. This cow weighed when eight years old 1,040 pounds. During the test at Chicago, where the conditions were far from favorable, this cow averaged over 40 pounds of milk a day for five months. She made 3 pounds of butter a day a number of times, 20½ pounds in a week, and 98 pounds more than any other cow in the test.

The Jersey is more largely kept in the United States than any other dairy breed.

567. *Guernsey cattle* — This breed is in many respects similar to the Jersey. It undoubtedly took its origin from the same ancestry. This

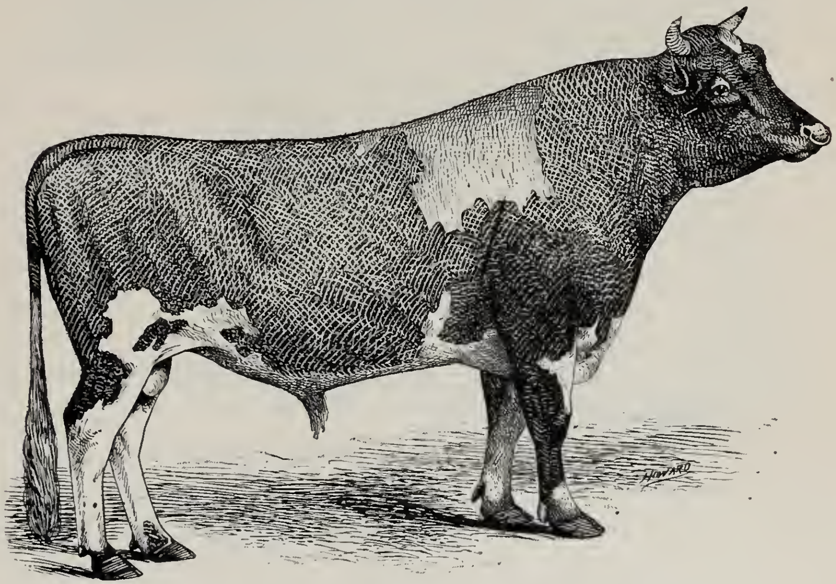


FIG. 175. GUERNSEY BULL, SHEET ANCHOR 3934.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

breed was produced on the island of Guernsey, which lies in the English channel, not far distant from Jersey. It is triangular in shape, nine miles long, and four miles in the greatest width. It has a total area of about 16,000 acres. There are only about 5,000 animals owned upon the island. Market gardening is the chief occupation of the inhabitants of Guernsey.

As in Jersey, so in Guernsey, the importation of living cattle has been for a long time prohibited. Guernsey cattle were probably first imported into the United States about 1850. At that time they, as well as cattle from the island of Jersey, were generally called Alderneys. The Guernseys first imported into this country were not kept pure, but about twenty-five years ago they were recognized as a breed, and since that time a larger or smaller number have been imported almost every year. The breed has increased quite rapidly in this country, and has usually gained in favor wherever it

FIG. 176. GUERNSEY COW, FANTINE 2D 3730.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

has become known. Guernseys differ from Jerseys in being a somewhat larger, stronger breed, and a little coarser in appearance. It is generally claimed that they are superior in constitution and hardiness. It may, however, be doubted whether this is the case. The Guernsey cow is distinctly of the dairy type. In color the breed shows less variation than the Jersey. They are generally light, yellow or orange fawn predominating, and patches of white on body and legs are almost the invariable rule. The nose is generally light or flesh colored, though occasionally a black nose is found. As

in the Jersey, there is a light ring about the nose, though it is much less pronounced than in that breed. In the color of the skin all over the body, and particularly the inside of the ears, the Guernsey is characterized by a deeper shade of yellow than any other breed. This high color appears also in the milk, cream, and butter, the latter being of a far deeper shade of yellow than that of any other breed.

Guernseys have the reputation of being somewhat more quiet in disposition than the Jersey, and the bulls are less frequently vicious. The quantity of milk yielded by Guernseys is fairly large, and the milk is remarkably rich in butter fat ; the average percentage of butter is possibly higher than in the milk of any other breed. Five per cent. butter fat is not at all uncommon. The fat globule, as in the Jersey milk, is rather large. The average weight of Guernsey cows is about 1,000 pounds, and being larger than the Jersey, it is claimed that the average milk yield is greater. This claim does not appear to be well supported by the facts. In the dairy test in Chicago in 1893, the Guernseys were beaten by the Jerseys in both quantity of milk and yield of butter. It is only fair, however, to state that the Guernsey breeders had a much smaller number from which to select than had the Jersey breeders. Yields of from 300 to 400 pounds of butter a year are not uncommon among Guernseys and individuals have frequently made up to 700 pounds of butter yearly. During the past year one Guernsey has made no less than 900 pounds of butter.

The cuts show two noted individuals of the breed. The bull, Sheet Anchor, is said never to have been beaten in the show ring and animals of his get are almost equally successful. His weight at the age of four years was 1,600 pounds.

The cow, Fantine 2d, was American bred and the portrait was made when she was eight years old and the udder was not more than two-thirds full. She made a record of 9,748 pounds of milk and 603 pounds of butter within eleven months.

The Guernsey, like the Jersey, is a very satisfactory breed to use in improving the butter qualities of the dairy herd. The improvement in the

color of the product of the cows of a herd which follows the use of a Guernsey bull is especially marked.

568. *Ayrshire cattle* — The native country of the Ayrshires is the county of Ayr in the southwestern part of Scotland. The surface of this country is very much broken and hilly, the climate moist but not severe. The natural pasturage is of such a character that animals must travel long distances in a day to satisfy their hunger. The exact origin of the Ayr-

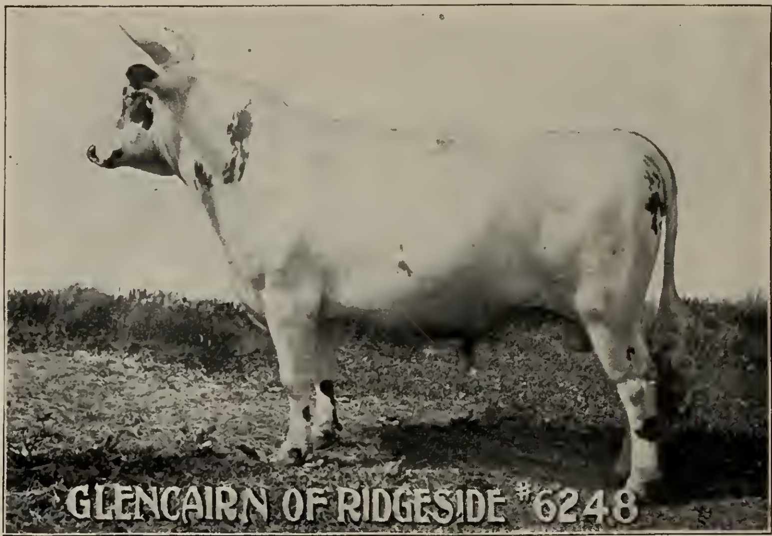


FIG. 177. AYRSHIRE BULL, GLENCAIRN OF RIDGESIDE.
By courtesy of C. M. Winslow, Sec. Ayrshire Breeders' Association.

shire breed is not known. Many believe them to be descended primarily from the wild white cattle preserved in the parks of a few noblemen in England. It is certain, however, that in bringing the breed to its present character the cattle of Ayr have been crossed with individuals of a number of other breeds. The Shorthorn, and cattle from Holland, and from the Channel Islands, are known to have been used. The improvement of the breed, as a result of the crosses made and the great care exercised, was very rapid during the latter part of the nineteenth century. The Ayrshire in its present form is, therefore, a comparatively new breed and is accordingly somewhat less fixed in type than some of the other breeds. The best Ayrshires show the

dairy type in perhaps its highest perfection. The bulls range in live weight from about 1,400 to 1,800 pounds ; the cows, from 900 to 1,100, the average perhaps being about 1,000 pounds. The Ayrshire as a breed is rather unusually short in the leg and the cows show the wedge form to a remarkable extent. This is not, however, due to unusual lightness in the fore quarter but rather to very large and full development in the hind quarters. The horns of the Ayrshire are usually symmetrical ; they turn first outward, then inward and upward, giving the head a very bold and upright appearance. The muzzle may be either dark or light, the former being generally preferred. The color, in the majority of instances, is some shade of red, and white. These two colors always exist in distinct patches, never mixed, the proportion of the two varying very widely. Of late years more white is preferred than formerly. The shade of red may vary from a bright cherry red to dark mahogany or chestnut. The udder is proportionally broader on the average than in most other breeds. It is remarkable for its extension forward and for its width, deriving its capacity rather from breadth and depth than from great length. The teats are usually widely and squarely placed and are inclined to be small, and it must be confessed not infrequently too short for easy milking. The Ayrshire, as a breed, is nervous and active. The bulls are usually gentle if well treated. The same is true of the cows. They however have a reputation for being somewhat quarrelsome among themselves and their sharp, upward-turning horns are often used as active weapons of offense. The Ayrshire is not exceeded by any breed in its ability to gather the needed food from scanty pastures. The Ayrshire cow is usually sprightly, quick, and active, and if there is good feed in the pasture she is sure to find it. She is preëminently a good "rustler." The breed is noted for a large milk yield in proportion to size. Individuals have given 12,000 pounds or more of milk in a year. There is a continuous record of one noted herd, averaging fifteen cows, which extends over twenty-one years. The average yield for the entire period has been 6,433 pounds of milk per cow per year. During the last year (1900), the herd numbered twenty-two cows and the average yield was 7,189 pounds. The average butter fat was 3.79 per cent.; the average total solids, 12.60 per

cent. Adding one-sixth to the average amount of butter fat to cover water, etc., the average butter yield of this herd for the year 1900 amounted to 315 pounds per cow.

An official test conducted by the Vermont Experiment Station, which included seven cows, resulted in showing a butter yield, in seven days, ranging from 10 to nearly 13 pounds per cow. Two other herds have recently made records as follows: One of twenty cows, an average yield of 6,362 pounds of milk per cow; the best ten cows of this herd averaged 7,253 pounds. The other herd of twenty-two cows made an average of 7,558 pounds of milk, containing an average butter fat content of 3.88 per cent., which with the customary addition of one-sixth is equivalent to a yield of 341 pounds of butter per year. It is not, however, as a butter breed that the Ayrshire has won its reputation. The butter globules vary widely in size, many of them being excessively small, and the color of the butter is comparatively light. It has been claimed that the milk of the Ayrshire was very especially suited for manufacture into cheese. This claim does not appear to be fully justified by the facts. Ayrshire milk is not richer on the average, in cheese-forming constituents, than the milk of cows of other breeds. The small average size of the butter globules, however, renders it easier to manufacture Ayrshire milk into cheese, in which the fat is well mixed with the body of the cheese, than is the milk of breeds in which the butter globule is larger. Ayrshire milk may stand for some time without the cream rising to nearly the same extent as would be the case with the milk of such breeds as the Jersey or Guernsey. This peculiarity of Ayrshire milk, viz., the small size of the butter globule, renders the milk also especially well adapted for family trade. It is more easily handled and delivered to customers in good condition, and the belief is widely held that, as the fat particles average much smaller in size, the milk is more readily and more easily digested than is the milk of such breeds as the Jersey and Guernsey. Ayrshire milk, therefore, is by many believed to be much better suited especially for the delicate and for infants, than is the milk of breeds like the Jersey or Guernsey, in which the fat globule is large and the percentage of fat higher. The Ayrshire cow, then, is believed to be partic-

ularly adapted to those situations where milk for family trade or the manufacture of cheese is wanted ; and where the conditions are such that a cow of an active, energetic disposition is required, where the pastures are hilly, and the cow must range long distances to gather the needed food, the Ayrshire cow is one of the best.

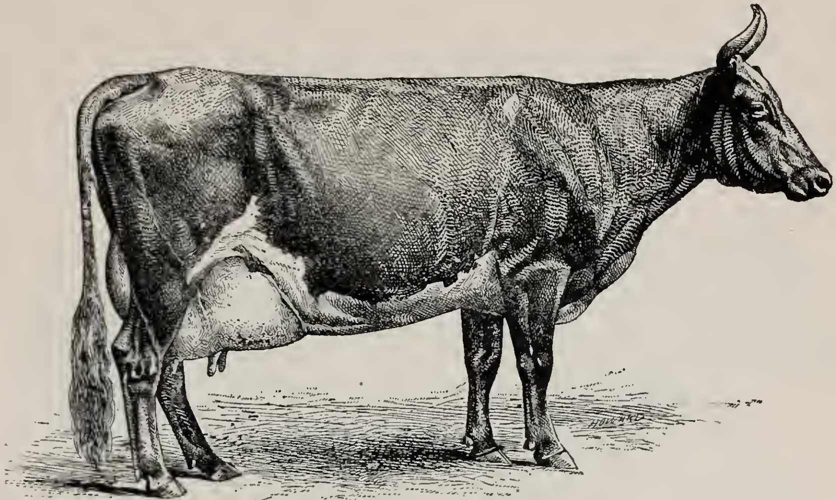


FIG. 178. AYRSHIRE COW, RED ROSE 5566.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

The cuts representing the bull Glencairn of Ridgeside and the cow Red Rose 5566 show the best type of the Ayrshire breed. Red Rose was imported into the United States from Scotland. At the time of the photograph from which the cut was made, she was five years old. Her milk product for one year was 8,578 pounds. Ayrshires were imported into the United States, first into New York in 1822, into New England in 1830. They were first imported into Canada in 1837. Between 1845 and 1874 there were almost yearly importations. Since that time comparatively few Ayrshires have been imported. Ayrshires are quite widely kept in the United States, but less extensively in proportion to the total number of dairy animals than in Canada, where the breed stands very high in the popular estimation.

569. *Holstein-Friesian cattle* — The native country of the Holstein-Friesian is a section of the Kingdom of Netherlands bordering on the North Sea, chiefly North Holland and Friesland. The farm lands in this

locality are for the most part low and rich, producing large quantities of luxuriant feed. The winters are long and severe, the summers comparatively cool. The breed is without doubt a very old one. It is claimed that its history can be traced back two thousand years. Certain it is that Holland has been noted for its dairy products for at least one thousand years. Houghton, in his history of Holstein-Friesian cattle, writes as follows: —

"The preservation of the Friesian people and their continued adhesion to cattle breeding for more than two thousand years is one of the marvels of history. Always few in number, the conflicts of war and commerce have raged over and around them, yet they have remained in or near their

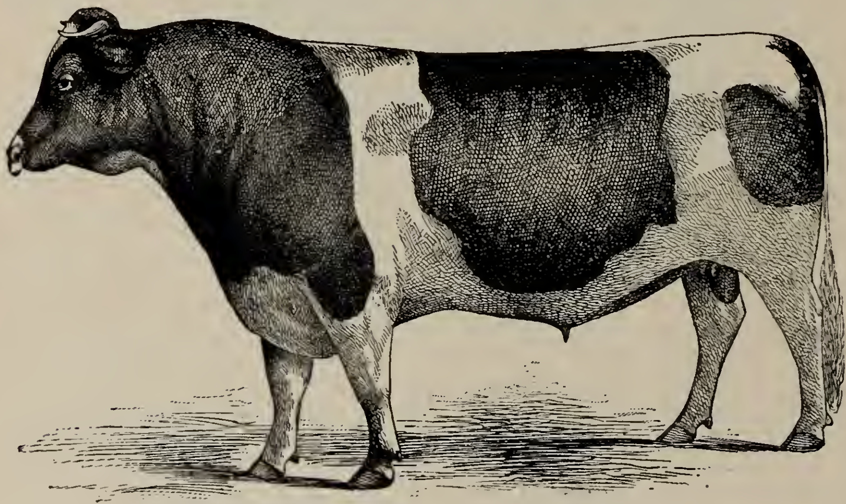


FIG. 179. HOLSTEIN-FRIESIAN BULL, DE BRAVE HENDRIK 230, H.-F. H. B.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

original home, continuously following their original pursuits. Their farmhouses are fashioned after the same general model, the one immense roof covers everything that needs protection. Here the cattle find shelter during the long and rigorous months. Here they are fed and groomed and watched for months without being turned from the door. Here the family is also sheltered, sometimes with only a single partition between the cattle stalls and the kitchen and living room. Everything is kept with a degree of neatness marvelous to those not accustomed to such system. The cattle become the pets of the household. At the opening of spring, or when

grass is sufficiently grown, they are taken to the fields and cared for in the most quiet manner. Canvas covers protect their bodies from sun, storm, and insects. The grasses upon which they feed are luxurious, and the animals have to move about very little to gather sufficient food. On the first appearance of winter they are returned to the stable and the simple round of the year is completed. This round is repeated until the cattle are six or seven years of age, when they are usually considered as past the period of dairy profit and are sent to the shambles. The object is always to produce as much milk and beef as possible from the same animal. With this two-fold object in view, selection, breeding, and feeding have been continued for ages."

Alvord says: "The large frame, strong bone, abundance of flesh, silken coat, extreme docility, and enormous milk yield of the Holstein-Friesians

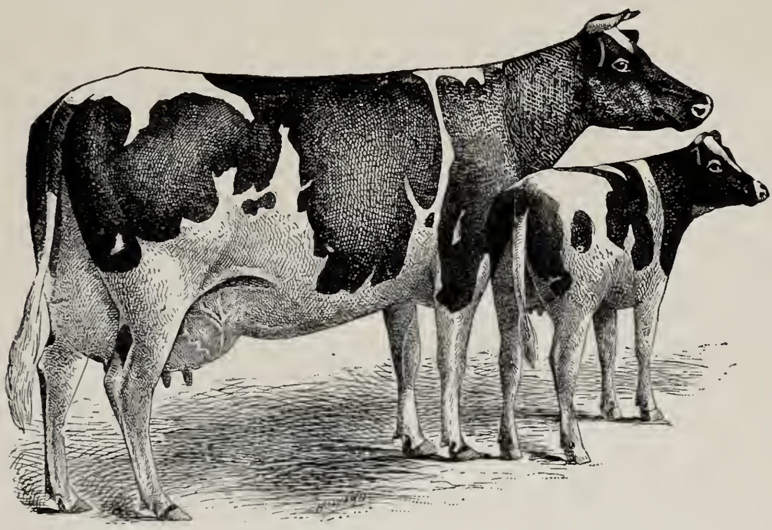


FIG. 180. HOLSTEIN-FRIESIAN COW, JAMAICA 1336, H. H. B., AND CALF.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

result from the rich and luxuriant herbage of the very fertile and moist reclaimed lands upon which the breed has been perfected, the uncommonly good care received from their owners, and the close association of people and cattle." There can be no doubt of the correctness of this opinion.

It appears certain that some of the early Dutch settlers in the United States brought these cattle with them, but the animals of those early

importations were not kept pure. The credit of making the first importation, the purity of which was maintained, belongs to W. W. Chenery of Massachusetts. A large importation was made into New York in 1867, and subsequent to that date this breed of cattle has increased rapidly in the United States, both by importation and natural increase. When first imported by Chenery, these cattle were known as "Dutch" cattle. Different importers have used still other names, among which Holland cattle, North Holland cattle, Holstein cattle, Dutch-Friesian, and Netherland cattle may be named. There was a bitter controversy for a time between different breeders as to which was the proper name and in the end the compromise Holstein-Friesian was adopted. The name "Dutch" cattle seems to the author preferable both because of its brevity and because it is sufficiently descriptive. Animals of this breed are quite widely kept in various parts of Europe, where they are generally known as Holland cattle.

Although preëminently a dairy breed, Holstein-Friesians show a somewhat less extreme dairy type than the cows of some other breeds. Hoxie says the type is what is technically called the milk and beef form, and he adds: "It is especially strong in all vital particulars. The bones are fine compared with size, and the chine broad and strong compared with the high and sharp chine of the extreme milk form. The loin and hips are broad and smooth, and the rump high and level, compared with the angularity usually shown in the milk form. The twist is roomy and the thighs and hocks well apart. Passing forward, the shoulders are smoother and more compact than in the milk form, but of lighter weight than in the beef form. The brisket is not so wide and low as in the beef form, and the chest is not so deep, but the width of the beef form through at the heart is closely retained. In the milk form the abdomen is usually swung low, and the ribs are steep, but in the milk and beef form the ribs are wider sprung and the abdomen more trimly held up, though no less capacious. The general appearance of the bull is strongly masculine, but that of the cow is no less feminine than in the milk form."

The Holstein-Friesian is the largest of the dairy breeds, although the size, as is no less true of other breeds, may vary quite widely according to the feed and care which the animal receives before reaching maturity.

Hoxie points out that the cattle of the sandy districts of the seashore in their native country average considerably smaller than those of other districts. The bulls of the breed not infrequently weigh 2,000 or even 2,500 pounds ; the cows usually range in weight between about 1,100 and 1,500 pounds, the average probably being in the neighborhood of 1,200 pounds. The only colors recognized in this country as proper to the breed are black and white in distinct patches. In their native country red is sometimes found and red and white animals are registered. In this country, even if known to be of absolutely pure blood, the red and white animal will not be accepted for registry. The horns are small and fine, usually turning first outward, then inward, and upward. They are usually white with black tips. The udder is very large and the teats unusually large, indeed not infrequently somewhat too large for easy milking. They are apt to be very thick and puffy next the udder. The temperament of these cattle is usually quiet and docile ; the bulls seldom become vicious. Holstein-Friesians have great constitutional vigor and the ability to consume, assimilate, and convert into profitable product a very large amount of food. The calves are very large at birth and are easily made to thrive and grow with great rapidity. There can be no doubt that this is one of the most profitable of breeds for the production of veal. It is, however, for milk production that the Holstein-Friesian cattle are most valuable. The amount of milk yielded is larger than for any other breed. The percentage of butter fat in the milk is however low, not infrequently under 3 per cent. and not usually very much above that figure. The butter globule is small in average size and the cream does not very rapidly separate from the milk on standing. This peculiarity of the milk renders it especially well fitted for family trade. There is little doubt that it is one of the best of milks for delicate persons and infants, the small size of the fat globule and the comparatively low percentage of fat rendering it somewhat more easily digested than is the milk of such breeds as the Jersey and Guernsey. Notwithstanding the comparatively low percentage of butter fat in the milk, the total yield is so great that Holstein cows produce in the course of a year a very large amount of butter. It is claimed for one cow of the breed that she produced within a

single year somewhat over 1,100 pounds. Cows making from 15 to 25 pounds of butter a week are not very uncommon, while some entire herds have been made to average over 17 pounds of butter per week. The Holstein-Friesian cow is a very persistent milker. Whole herds may be made to average 7,000 to 8,000 pounds of milk per year ; while individuals have occasionally yielded more than three times the larger of these amounts. There is one well authenticated record of a yield of slightly over 100 pounds of milk per day for thirty consecutive days. There can be little doubt that the Holstein-Friesian under suitable conditions will produce milk at less cost per quart on the average than any other breed. That they will produce butter as cheaply as cows of some other breeds seems doubtful. The milk of the Holstein-Friesian not infrequently contains too low a percentage of total solids to satisfy the requirements of the legal standard established in some of our states and cities. There are some families in this breed producing milk of much better quality and no doubt, though probably with some decrease in quantity, the average quality of the milk of the entire breed may be easily raised. The butter made from Holstein milk has good keeping qualities but is pale in color. The milk is well adapted for manufacture into cheese.

Holstein-Friesian cattle are most at home where a system of intensive farming is practiced, where the pastures are rich, and liberal feeding the rule. Their numbers have increased rapidly of late years, in the richer and more important dairy sections of the United States. The cuts presented as types of the breed are both those of imported animals. The bull in his native country, Holland, was selected by an official committee as the best bull in North Holland. His weight at the age of four years was 2,300 pounds. The cow in her second milking period made a yield of 20,000 pounds of milk ; and during this year, when in full flow of milk, made 23½ pounds of butter in seven days. Alvord states that her feed when giving her largest flow of milk was 28 pounds of grain per day, with beets and good hay. She had access to water five or six times daily and was milked every eight hours. The number of Holstein-Friesians in the United States is now quite large. They rank next to Jerseys among the pure dairy breeds. The

association of Holstein-Friesian breeders has pursued a most intelligent and energetic course in its efforts to disseminate information, and in all ways to promote the improvement and the general introduction of its favorite cattle. This association was the first to establish a separate system of registry for animals of proved excellence and quality,— the so-called system of "advanced registry."

570. *Dutch Belted cattle* — Dutch Belted cattle are with little doubt descended from the same original stock as the Holstein-Friesian. Their native country is Holland, and it has been claimed that in that country they

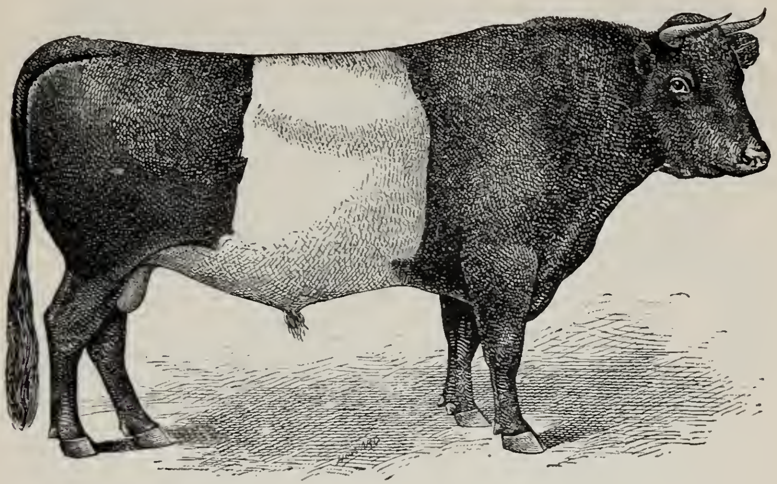


Fig. 181. Belted Dutch Bull, Duke of Ralph 255.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

were kept for a long time almost exclusively by members of the royal family and the aristocracy. Like the Holstein-Friesians, these cattle are black and white ; but the distribution of the color is quite different and very unique and striking. There can be no doubt that, in the effort to fix the peculiar markings, the animals of this breed were more closely bred than is usually desirable. Some of the more valuable and practical characteristics appear to have been in a measure lost sight of. In size Dutch Belted cattle rank about with Ayrshires. They are, however, rather longer in the

leg and somewhat less compact in form than the cattle of that breed. The color is black with a band of white extending entirely around the body. This belt of white differs in width, but it should not extend forward to the shoulder nor back to the hip. There must be no white elsewhere on the body and no black must appear in the white belt. Dutch Belted cows yield a fair amount of milk. In quality this milk stands rather low, though it will average somewhat richer in butter fat than the milk of the Holstein-Friesians. The breeders of Dutch Belted cattle naturally claim very much

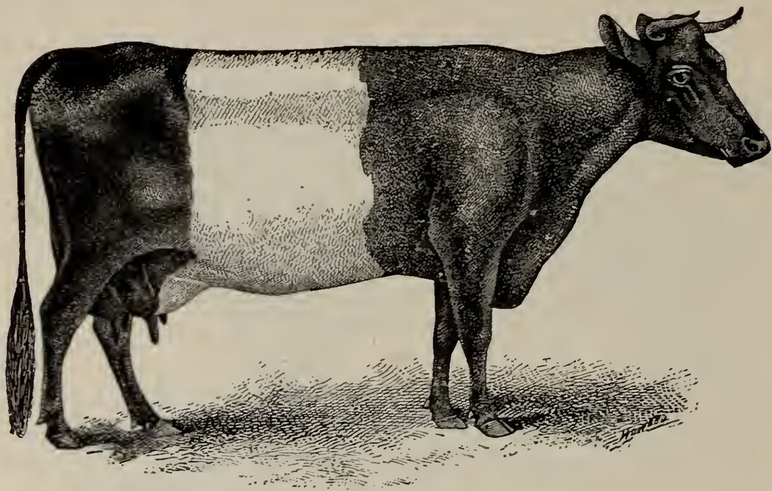


FIG. 182. BELTED DUTCH COW, LADY ALDINE 124.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

for their favorites, but their claims appear to be hardly justified by the facts. The breed is not numerous, either in its native country or in the United States, and it cannot as yet be regarded as of much importance. The cuts give a good idea of the appearance of two of the finest individuals of the breed.

571. *Brown Swiss* — Brown Swiss cattle are natives of Switzerland, a country which has long possessed a most enviable reputation for its dairy products, especially for its cheese. This breed of cattle, being native to a hilly and mountainous country, shows the natural peculiarities resulting

from life in such a country. Most important among these characteristics are the somewhat larger and stronger bone and leg than are common among lowland cattle. The cows usually range in weight from about 1,200 to 1,400 pounds, the bulls about 1,880 pounds and somewhat above. It may be noted that the bull is not so much heavier than the cow as in some breeds. Brown Swiss cattle show a fairly well developed dairy form, but they are somewhat more compact and better rounded than some of the more highly specialized breeds. The color is brown, sometimes shading into

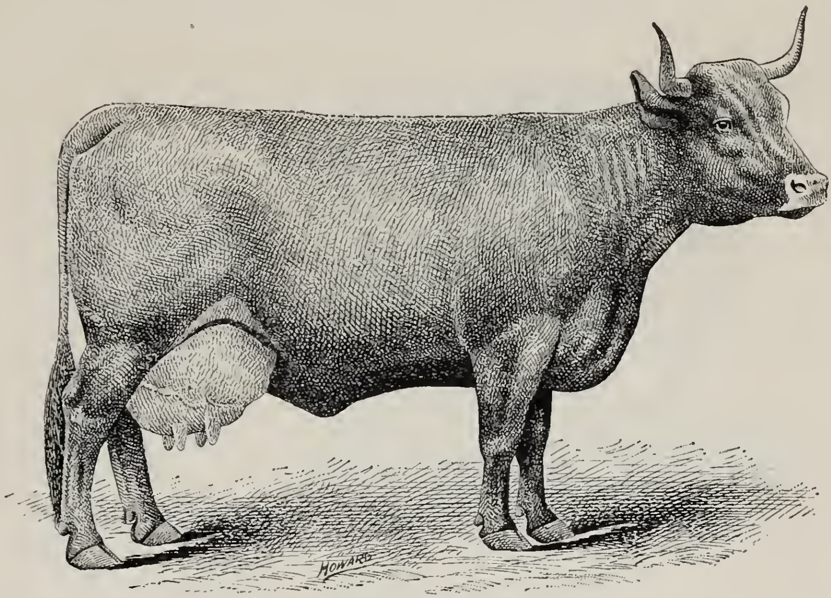


Fig. 183. Brown Swiss Cow, Brienzi 168.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

gray. The muzzle is mealy. There is a lighter tuft of hair between the horns and a light stripe along the back. The animals of this breed show a close general resemblance in coloring to the Jersey, and a novice, not looking very closely, may easily mistake the Brown Swiss for the Jersey. The best Brown Swiss cows are large milk producers, 6,000 pounds per year being common, while 10,000 pounds are frequently reached. One cow of this breed, kept in Massachusetts, made a yield of 86,304 pounds of milk

before she was twelve years old, and for four years, when in her prime, made from 500 to a little more than 600 pounds of butter per year. The calves of this breed are large at birth, healthy, and grow rapidly. Brown Swiss cattle are much better for beef than are the cattle of the more highly developed dairy breeds. The quality of the beef is good. Oxen of this breed are usually strong and serviceable work animals. It is claimed that in their native country these animals are fed on grass or other green fodders and hay only. The number of Brown Swiss cattle in the United States is still comparatively small, and it may be doubted whether it will ever become a breed of the first importance for the general purpose farmer. It is not, perhaps, sufficiently highly specialized to suit the demands of our civilization. It is an excellent animal for all purposes, but perhaps hardly good enough in any to make it a general favorite. The cut gives a good idea of the appearance of Brown Swiss cattle of the best type. The cow, Brienzi, at the age of eleven years, weighed 1,410 pounds, and has the honor of having produced the largest quantity of butter fat in a day ever recorded in America, in a public test. Her average record for three days in a fat stock and dairy show in Chicago in 1891, was 81.7 pounds of milk, containing 3.11 pounds of fat. This was equivalent to more than 3½ pounds of butter daily.

FIG. 184. ABERDEEN ANGUS COW, WATERSIDE MATILDA II. 6312.
After Wallace.

572. *Other breeds sometimes included in the dairy class* — There are a few other breeds of cattle which are put by some authors into the dairy class, but which the writer will describe at length, under a separate class,

known as dual purpose animals. Among these breeds are sometimes found individuals possessing excellent dairy qualities ; and in some of the breeds the *average* dairy quality of the cow is good. Still, all fail to have that average dairy quality which, in the opinion of the author, is necessary to entitle a breed to a position in the dairy class ; and all, moreover, are of much value for beef, some of them, as would be admitted by all writers, being far more prominent as beef than as dairy animals. These breeds are the Shorthorn, Polled Durham, the Devon, the Red-Polled, Simmenthal, and Normandy. Among Shorthorns are found occasional very deep milkers and some families produce a large number of good dairy animals. In quality, Shorthorn milk is about like that of the Ayrshire.

The Polled Durham is nothing more than a hornless Shorthorn, and of the quality of the breed for dairy purposes the same may be said as of the Shorthorn.

Many families of Devons originally possessed better dairy qualities than at the present time. The breed is in general characterized by the yield of a moderate quantity of milk of unusually good quality and high color.

The Red Polled cattle are somewhat similar to Devons as regards dairy qualities. They produce a moderate quantity of milk, though rather more than the Devons, and of good quality.

Among Simmenthal cattle are found a considerable proportion of good milkers. The same is true of the Normandy. This breed is fully described in paragraph 587.

LXXXIV — BEEF BREEDS.

573. *The more important beef breeds named* — But four of the breeds of cattle which are valuable almost exclusively for their beef qualities are kept to any considerable extent in the United States. These are the Hereford, Galloway, Aberdeen-Angus, and Sussex. Two others will be described, however, because of the especial interest which attaches to them, viz., Longhorn and West Highland.

574. *The ideal beef type* — Before attempting the description of the different breeds of beef cattle, an attempt will be made to give a clear idea of the usual type of the animal kept for beef production ; and the student is

advised to refer in connection with this description to the cut of the Aberdeen-Angus cow, Waterside Matilda, a noted prize winner in the fat stock exhibitions in Scotland.

Head — Small, lean, and bony. Relatively broader and shorter than in the dairy type.

Muzzle — Broad and full.

Eyes — Large, full, clear, and quiet in expression.

Ear — Large, full, well covered with hair, and lively.

Neck — Rather short, relatively considerably shorter than in dairy breeds, thin where it joins the head but very full and thick at the shoulder.

FIG. 185 HEREFORD HEIFER, PRIMROSE
After Wallace.

Throat — Clean.

Chest — Broad and deep. The section behind the shoulders should be nearly a circle.

Brisket — Deep. It should project well forward and should be full.

Shoulders — Upright and wide at the points, and thick even at the top.

Crops — Full and level with the shoulders and back. There should be no hollow behind the shoulders.

Back — Straight, broad, and level. Hip bones far apart and well covered with flesh. Rumps high, with plenty of flesh.

Pelvis — Large.

Quarters — Long and straight, thick, well developed downward, and the lower part of thigh also thick and full.

Ribs — Springing out broadly from the back, and deep.

Flank — Deep, wide, and full.

Tail — Should be flat and broad at its root but fine below. It should be attached to the body high up and on a level with the rump.

The body taken as a whole should be long and deep, thick both before and behind. Looked at from any point, it should resemble a parallelogram as nearly as possible, the under and upper lines being straight and parallel. The legs should be short and stout. As some one has fittingly expressed it, the animal kept for meat production "should have one leg on each corner of the body,— not two legs at each end." The udder shows very inferior development as compared with the dairy breeds, although in spite of much smaller size it should show the same general form and peculiar texture. The coat should be thick, and as a rule short and fine in summer, though it may be quite long in winter.

The *skin* should be moderately thick, but soft and elastic. It should move freely beneath the outspread hand above the ribs and should raise easily from the body between thumb and finger whenever the animal is in good condition.

The body of the beef animal as a whole is far better rounded and more compact than that of the dairy animal, and the whole appearance indicates tranquillity, quietness, and a disposition to lay on flesh and fat.

575. *Hereford cattle* — The native country of the Hereford cattle is the county of the same name in England. It is believed that these cattle derived much of their blood from a race of cattle at one time wild in Great Britain. The improvement of the breed first became very marked in the latter half of the eighteenth century. Both in England and in the United States there has been a long and lively contest between Shorthorn and Hereford breeders, concerning the relative merits of their favorites as beef animals. In both countries they have long been among the most prominent beef breeds ; and, where animals of the two breeds have met in competition in fat stock exhibitions, the highest awards are carried off now by one, now by the other breed. The rivalry between the breeders of these cattle is perhaps not to be wondered at, and yet there is no real occasion for mutual jealousy. Both breeds are of much value and there is a place for both. It will be generally admitted that the Hereford will do somewhat better than the Shorthorn at pasture or on grass alone. It may not be as generally admitted, yet it is perhaps true, that the Shorthorn will generally do some-

what better in close confinement on liberal feeding. Fat Hereford cattle are said to be brought into the English markets mainly in late summer and in autumn, coming only from grass. Herefords were imported into the United States early in the nineteenth century, but not many until 1850. Since 1879 there have been many and large importations, and in numbers in this country this breed stands second only to the Shorthorn among beef animals. In color the Hereford is red of various shades, with a white face and a white line extending sometimes from the head to the tail, though often not reaching much, if at all, back of the shoulders. The belly also is white, the brush white, as well as the feet and the lower part of the legs. The Hereford usually presents the beef form in about its highest type. The cattle have very little value for milk. In size the bulls usually range from about 1,900 to 2,300 pounds; the cows from 1,200 to 1,600 pounds. Herefords have good constitutions, are hardy, and have good ability to thrive with comparatively little shelter and on pasture alone. The carcass of the well-fattened Hereford has a very large proportion of fat, although less than that of some other breeds. The fat is intermixed with the lean to a moderate extent, the beef of the best specimens being considerably marbled. In quality the beef is good. Hereford oxen make excellent animals for work, and they and their grades are considerably used for that purpose in some parts of New England. The cut clearly shows the characteristic appearance and the fine beef quality of the breed. It is that of a heifer, champion in her class at some of the great fat stock exhibitions in England.

FIG. 186. GALLOWAY HEIFER, CLARA VI. 10,513.
After Wallace.

576. *Galloway cattle* — Galloway cattle take their name from a district

in Scotland where the breed took its origin. According to Wallace, a great authority on the British breeds of live stock, Galloways are probably descended with little admixture of outside blood from the wild forest cattle of Great Britain. These cattle at the present time are hornless, but up to about one hundred years ago many among them still had horns. The breed also showed frequent variations from the present color, which is black; reddish brown with white patches on the belly being then common. Galloways, however, have been for the most part hornless for nearly two hundred years. In size the Galloway ranks as a medium to large animal, bulls ranging between 1,700 and 2,100 pounds, cows between 1,000 and 1,400 pounds. The color is an unbroken black. The hair is usually long, thick, and fine, sometimes slightly tinged with brown. It is said that the hides of the best animals, tanned with the hair on, are sometimes of much value as robes or for the manufacture of fur coats, etc. The Galloway is an animal of great constitution and hardiness. Animals of this breed are among the best for the western ranges, on account of their ability to shift for themselves and to endure the severe storms and low temperatures common in many localities. The carcass shows rather less external fat than that of some of the other beef breeds, and the meat is better marbled than many and of quite superior quality. The breed is worth little for milk, although the quality of the milk produced is rich. Galloways in the United States are important only in the West. The cut, showing a heifer, Clara VI., prize winner in Scotland, gives a good idea of the general characteristics of the breed.

FIG. 187. ABERDEEN-ANGUS BULL, THE BLACK KNIGHT 1809. *After Wallace.*

577. *The Aberdeen-Angus* — According to Wallace, the Aberdeen-

Angus cattle were probably originally of the same stock as the Galloways, to which they still bear a very close resemblance. The Aberdeen-Angus cattle, however, have been to a considerably greater extent modified, refined, and, as some would say, improved, through the agency of man; a number of skillful breeders having devoted themselves for many years to this work, in the course of which the original cattle were crossed with animals from a number of other polled breeds of Great Britain, as well as with some of the horned breeds. In-breeding was finally practiced to a considerable extent, as in the case of all the other prominent beef breeds, in order to produce greater uniformity and to more firmly fix the type. The Aberdeen-Angus differs from the Galloway chiefly in being somewhat larger, and finer in bone, head, and hair. It is still a hardy breed of cattle. The bulls usually range in weight between 1,800 and 2,200 pounds, cows between 1,100 and 1,500 pounds. The systematic improvement of this breed in Scotland first became marked soon after 1800. As a further result of the efforts to improve the breed, it will now be generally admitted that it presents a more perfect beef rectangle than the Galloway, and will give a somewhat larger proportion of dressed to live weight. Between the two breeds there should be no real rivalry. Both are needed; the Galloways for roughing it, the Aberdeen-Angus for localities where feed is more abundant, pastures rich, and where man is prepared to give shelter and care. In quality the beef of the Aberdeen-Angus averages about the same as that of the Galloways. The importation into the United States began about 1873, and since that date many of these animals have been im-

FIG. 188. SUSSEX OX.
After Wallace.

ported. It now considerably outnumbers the Galloways, and is kept largely in the Middle West. The breed has no value for dairy purposes. The cut shows a very fat cow, the winner of the first prize at the chief fat stock exhibition in England in 1887.

578. *Sussex cattle* — Wallace is of the opinion that Sussex cattle are descended from the old race of cattle wild in Great Britain, from which the Hereford, Devon, and some others derived most of their blood. Sussex cattle were originally not distinct from the Devons, and even at the present time there is a close resemblance between the two breeds save in size. The Sussex is considerably larger than the Devon, bulls ranging in live weight between about 1,700 and 2,000 pounds, cows between 1,100 and 1,400 pounds. In color the Sussex cattle are the same as the Devon. They are a little coarser in the head and with somewhat longer and stronger horns. They are of the beef type and have not as much value for milk as the Devon. They make excellent working oxen. A few of them have been imported into the United States but they are not of much importance as yet in any part of the country, although to this breed belongs the honor of having furnished the winner in one of the recent fat stock exhibitions in Chicago. The cut shows a fat ox, the winner in one of the great English exhibitions of fat cattle in 1886.

FIG. 189. LONGHORN COW.
After Wallace.

579. *Longhorn cattle* — This breed of cattle was at one time prominent in England, but at the present time it is not of much importance in that country and is probably not represented in the United States in any considerable numbers, if at all. It is mentioned chiefly because it is the breed with which Bakewell, who is considered the father of the modern system of

breeding, first demonstrated the possibilities of the breeder's art. Bakewell died at the age of seventy years in 1795. He effected enormous improvement in this breed of cattle, increasing the weight, refining them in every respect, and greatly increasing the tendency to take on fat. In many respects Longhorns resemble Shorthorn cattle. They are about like them in size, form, and in mildness of disposition. They are somewhat coarser in the bone and in the quality of their flesh. They are not so early to mature. Animals of this breed have enormous horns, often growing downward and turning inward, and sometimes requiring to be cut off, lest they should grow into some part of the head or face. Longhorns show about the same color as Shorthorns, with brindle added. They are of exceedingly little value for milk. The cut shows a very fat cow which belonged to one of the best herds of Great Britain.

FIG. 190. WEST HIGHLAND HEIFER, LADY FLORA. *After Wallace.*

580. *West Highland cattle* — The West Highland breed of cattle took its origin among the Highlands of Scotland. Although a mountain breed, these cattle show the typical beef form in a high degree of perfection. Though small in size they are comparatively short in the leg, fine-boned, compact and blocky of form, and on good feed they soon become exceedingly fat. The color is various, from black to creamy yellow or white, through all the shades of dun, red, and brown. They are also sometimes brindled. Of late black is the favorite color. Bulls vary in size from about 1,100 to 1,600 pounds ; cows from about 700 to 1,000 pounds. This is the hardiest of all the British breeds. It has never been subjected to confinement to any considerable extent and is remarkably fitted to win a liveli-

hood from bold and rocky slopes and comparatively scanty pastures. The hair is unusually long and shaggy, affording splendid protection from inclement weather. In the quality of its beef the West Highland is not surpassed by the cattle of any other breed. This breed is of no importance in the United States at the present time. Indeed, it is not known to the writer that it is represented here. It may have a future in regions similar to those of its native highlands where the larger beef breeds would fail to thrive.

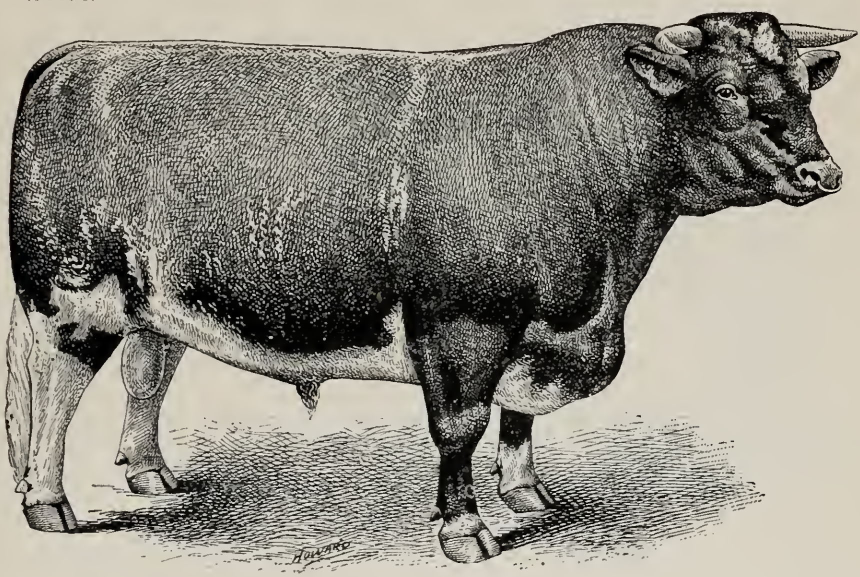


FIG. 191. SHORTHORN BULL, BARON CRUIKSHANK. BEEF TYPE.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

LXXXV — DUAL PURPOSE BREEDS.

581. *General characteristics* — Although differing very widely among themselves, all the dual purpose breeds have this in common : that they are in favor among different breeders both as beef and as dairy animals. Many of them also are unusually well fitted for work and some writers and speakers use the term "general purpose" animals in referring to some of them. Most of the dual purpose breeds which will be here considered are, in the opinion of the writer, of much greater importance as beef animals than as

dairy animals. It is not denied that among them are sometimes found individuals of great value as dairy cows, but it will hardly be denied that the average milking qualities, even of the best families in these breeds, is inferior to that of the dairy breeds. It will be argued by some that, even if this is the case, it will pay to keep for dairy purposes a dual purpose breed because the cow when past her usefulness in the dairy will be worth so much more when sent to the shambles. From this opinion the author is inclined to dissent. This is an age of specialization and it is believed that the animals kept for dairy purposes should be dairy specialists. The profit on them should be made during the period of their useful life in the dairy, and this profit should be sufficiently great so that the question of what the animal may be worth when sent to the shambles may be disregarded. It is believed that the profit which can usually be counted upon during the useful life of the dual purpose cow as a dairy animal will be sufficiently greater to much more than offset what the latter may be worth when she goes to the butcher. The dairy farmer should keep for a cow a dairy specialist ; and the fact that this is the general conclusion of practical men is sufficiently evident in their practice. Practical men conclude that they cannot afford to pay the board of the dual purpose cow during a considerable share of the time, simply because after they have done so for a number of years she will bring a good sum of money when sent to the butcher. Most of the dual purpose breeds approach much more nearly to the beef than the dairy type. Indeed, many families and a great majority of the individuals from some of these dual purpose breeds show the beef type in its very highest development.

582. *Shorthorn cattle* — The Shorthorn breed of cattle is possibly the most important among all the pure breeds. It certainly outnumbers any other pure breed and it has with little doubt played a greater part in the improvement of the common stock of Great Britain and all her colonies, as well as of the United States, than any other breed. The Shorthorn was so called originally to distinguish it from the Longhorn, which was once its most formidable rival. The breed was first brought to a high degree of perfection in the counties of Durham and York and it was once commonly known as the Durham or Yorkshire breed, while other names sometimes

applied to it were Teeswater and Holderness. The name Durham is still not infrequently used. Wallace says : —

"It was probably originally formed, though perhaps several centuries ago, by crossing the aboriginal British cows with large framed bulls imported from the Continent — Holland and Denmark. . . . Early Shorthorns were good milkers, and it may be presumed that they, in part, inherited that quality along with the shortness of horn from their continental ancestors.

"Little is known of the breed, except from the uncertain authority of tradition, down to the early part of the eighteenth century, though it is only right to infer that long before this time great care, and even skill, had been bestowed upon it. The earliest records show that purity of breed was fully appreciated, and this important fact could not have been universal without previous experience and attention. Though the first volume of the 'Shorthorn Herd Book' was not published until 1822, yet, for well-nigh a century, pedigree records, of a more or less imperfect kind, had been kept of a few of the best bulls."

FIG. 192. SHORTHORN HEIFER, AUGUSTA IV. BEEF TYPE.
After Wallace

The brothers Charles and Robert Colling, who were born about the middle of the eighteenth century and died about the end of the first quarter of the nineteenth, did much to improve this breed and to extend its reputation. This was due, first, to their skill as breeders, and, second, to their great business ability. A large proportion of the Shorthorns of the present day trace back to the bull Hubback, calved in 1795, and his descendants,

Favorite and Comet, who were owned by the Colling brothers. They practiced in-breeding very persistently; Favorite, who was an animal of unusual quality, being used upon his daughters, granddaughters, and great-granddaughters. The offspring of the last, *i. e.*, Favorite's great, great-granddaughter, produced by this course of breeding, had fifteen-sixteenths of the blood of Favorite in her veins. The Shorthorn in a great majority of instances shows the beef type in nearly its highest perfection. It is the largest

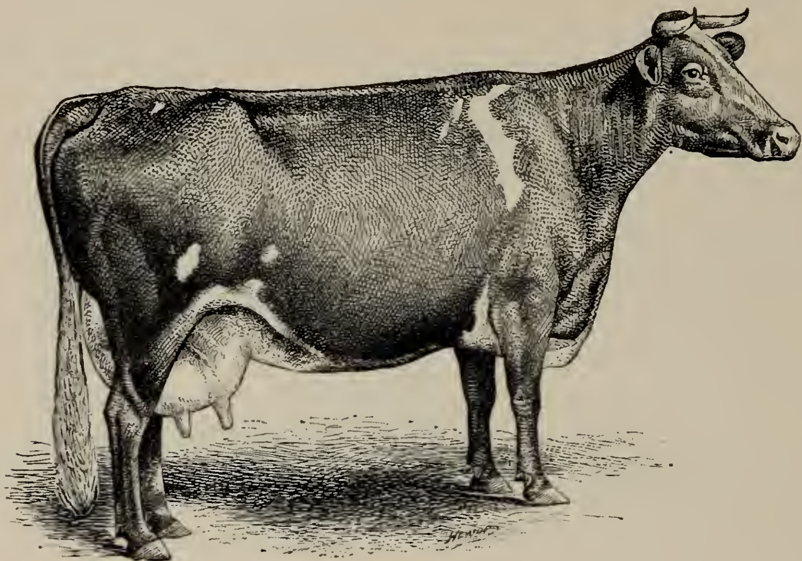


FIG. 193. SHORTHORN COW, KITTY CLAY IV. DAIRY TYPE.
By courtesy of H. E Alvord, Chief Dairy Division, U. S. Dept. Agriculture

of the pure breeds as judged by the scales, although, owing to the shorter leg and more compact figure, it may not have the appearance of being equal in size to some of the larger Holstein-Friesians. Bulls ordinarily weigh 2,000 pounds or more and from that up to 3,000, while cows range as a rule between about 1,200 and 1,600 pounds. In color the Shorthorn may be either red or white, or any conceivable mixture of these two colors. It must not show any black. In England that intimate mixture of red and white hairs known as roan is a favorite color; in the United States breeders

in general prefer more red, although roan animals are frequent in the United States as well as in England. In temperament the Shorthorn is peculiarly quiet and placid. They mature early and fatten readily and are without doubt one of the very best breeds for the production of beef, under a system of intensive farming in which the cattle receive good care and an abundance of feed. Among the first Shorthorns of America, cows yielding very large amounts of milk were common, but at the present time it may be justly said that milking qualities have as a rule been sacrificed for the sake of greater development of those characteristics which increase the value of the animal for beef. Shorthorn cows are still in some instances excellent dairy animals, but as a rule, while not a few give a large amount of milk soon after calving, they are not persistent milkers. The rate at which the milk yield falls off, with lapse of time after calving, is generally more rapid than with the dairy breeds proper. With rich feeding, a cow of the dairy temperament still puts all the food she can digest into the pail ; the Shorthorn soon begins to put her food on to her back. A few Shorthorns were imported into the United States before 1800. A number of importations were made early in the last century. Since that time there have been numerous importations and Shorthorns have been very carefully bred in various parts of the United States, though most largely in the Ohio and Mississippi valleys. About thirty years ago, British breeders acknowledged that the United States possessed better Shorthorns than could be found in England, and at the Mills sale in New York, in 1873, they were represented by agents sent over to purchase some of the best animals at any price. In this sale 109 head of Shorthorns were sold at auction in three hours for $380,000 ; one cow sold for $35,000, and another for $40,600. It is believed that these are the highest prices ever paid for cattle in any part of the world. At the present time there are more Shorthorns in the United States than of any other pure breed, though they have not increased as rapidly of late years as the Jerseys. Fig. 191 shows a bull, a splendid representative of the most highly developed beef type among Shorthorns. This bull was bred in Scotland and imported into the United States. Fig. 193 shows a cow that was among those representing Shorthorns at the great dairy test

in Chicago, and was the champion cow of her breed in the butter test. During this test she made 62¼ pounds of butter in the thirty-day trial from 1,593 pounds of milk.

583. *Polled Durham cattle* — This is a breed of American origin. It appears to be practically the Shorthorn without horns. The foundation stock was chiefly Shorthorn, although in fixing the hornless characteristic

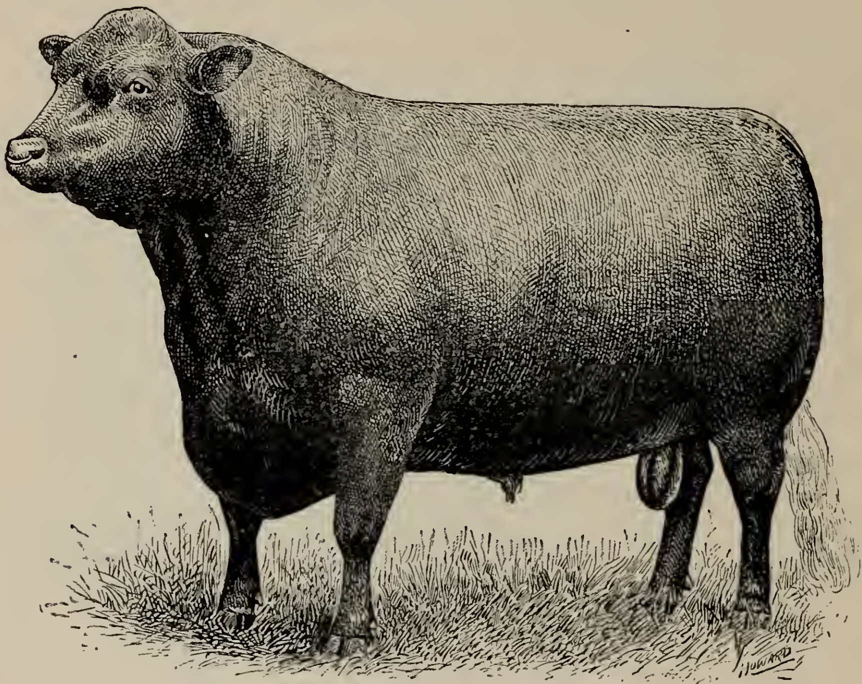


Fig. 194. Polled Durham Bull, Young Hamilton 39.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

hornless animals of other breeds were for a time employed. The presence in these animals of any blood other than that of the Shorthorn is not at the present time looked upon with favor. Since 1899, no cows are admitted to registry in the herd book of the American Polled Durham Breeders' Association, containing less than 96⅞ per cent. of Shorthorn blood, unless the parents are already registered. In size, form, and color, the Polled

Durham is like the Shorthorn, and the same may be said of its characteristics as a beef and dairy animal. These cattle are chiefly kept in a few of the states of the Mississippi and Ohio valleys. According to Alvord, the number of living animals in 1899 was about 1,200. The breed, therefore, has not as yet any considerable importance, but, since cattle without horns are now such general favorites, it may well be believed that the Polled Durham will in time become a very popular and useful breed. The cuts represent a bull at the age of four years, live weight 2,700 pounds, and a cow of unusually good dairy qualities for the breed, weighing 1,400 pounds when at her best.

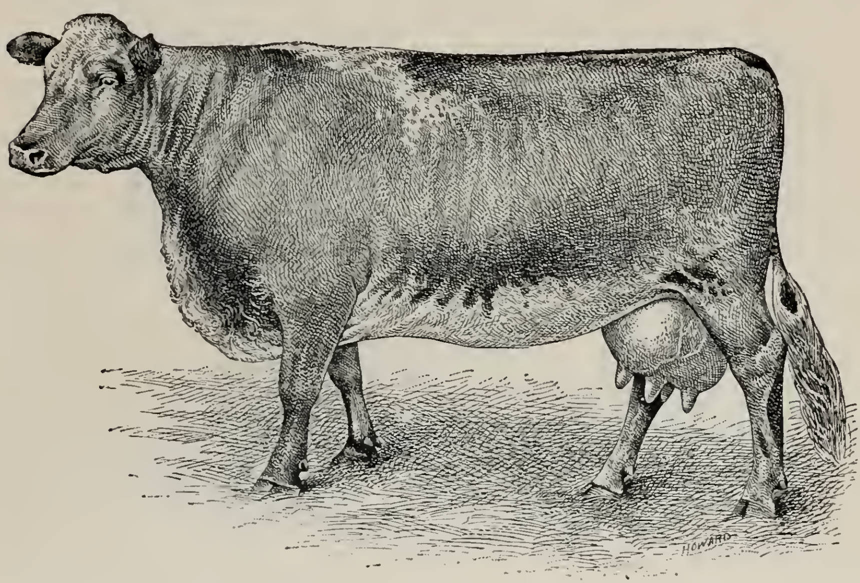


FIG. 195. POLLED DURHAM COW, DAISY II. DAIRY TYPE.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

584. *Devon cattle* — Devon cattle take their origin in the southwestern part of England. They take their name from the county of Devon, in which they were brought to their highest perfection. This is one of the very oldest of the known breeds of live stock. This fact is strongly indicated by the high degree of uniformity of the breed, by the solid color, by the

fixity of the type, and by the certainty with which Devon characteristics are transmitted when these animals are crossed with other breeds. Devon cows were originally animals of very good dairy qualities, giving a fair amount of milk unusually rich in quality. In recent times far more attention has been paid to the development of the finer characteristics for beef than to the preservation of dairy qualities, and most Devons at the present time are of the beef type, although somewhat less thickset and blocky than in the most highly developed beef breeds. The Devon is character-

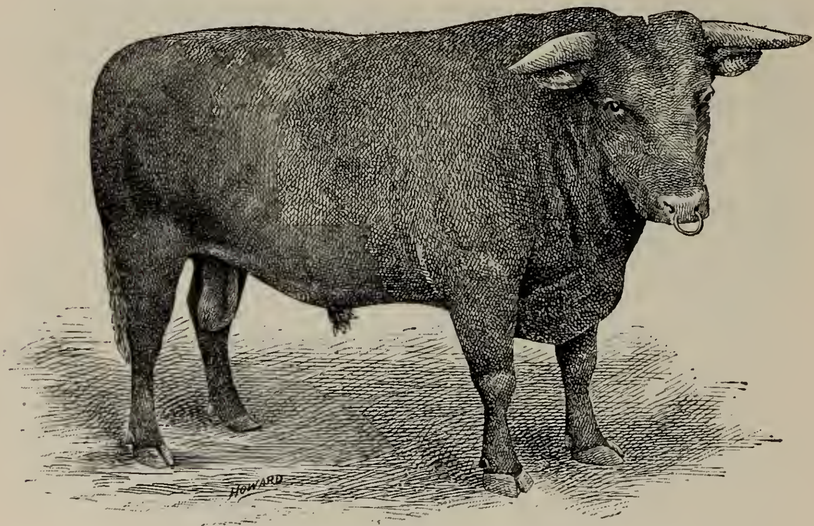


FIG. 196. DEVON BULL, FINE BOY OF POUND 6185.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

ized by a well-knit frame and compact and well-rounded form, but is less massive than the ideal beef type. In size the Devon ranks about with the Ayrshire. The color is red, differing somewhat in shade, but usually dark or bright cherry red. The hair is often curly, the horns turn outward and upward, and are white with black tips. Devons are exceedingly active animals and are very hardy. They will do well on lighter pastures than those required by the heavier beef breeds. In quality Devon beef surpasses that of most breeds, there being somewhat less external fat. The

beef is often beautifully marbled, is of fine texture, rich, juicy, and tender, as well as of excellent flavor. Devon oxen are among the best for the general work of the farm and the road. They have not the great weight enabling them to move enormous loads, sometimes required of animals working in stone quarries or similar locations, but for the ordinary work of the farm, plowing, harrowing, etc., Devon oxen are not surpassed by those of any other breed. They are very easily matched, both as to fancy points, color, shape of horns, etc., and, what is more important, as to the practical points

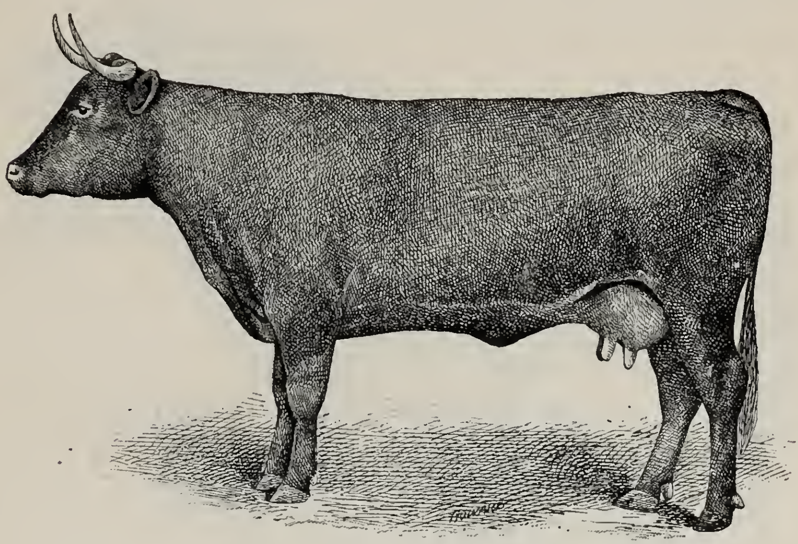


FIG. 197. DEVON COW, MISS T. 9605.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

of disposition, action, etc. Devon cattle were among the very first brought to the United States. According to Alvord, animals of this breed were brought to New England on the ship Charity in 1623. These early cattle were not kept pure, and the first animals of the breed whose purity was maintained were, according to the same authority, imported in 1817. Devons have never become very widely popular in the United States. The portrait shows an imported bull at the age of four years, when his live weight was 1,850 pounds. The cow is shown at the age of seven years, when

her weight was 1,450 pounds. Alvord states that this animal was a fine dairy cow, her ordinary milk yield being 30 to 35 pounds per day, 20 pounds of her milk always making a pound of butter.

The cattle which have been spoken of simply as Devons represent the best type of the breed. They are sometimes spoken of as North Devons, to distinguish them from cattle of the southern part of the county known as South Devons, which are larger and coarser and of much less value for dairy purposes.

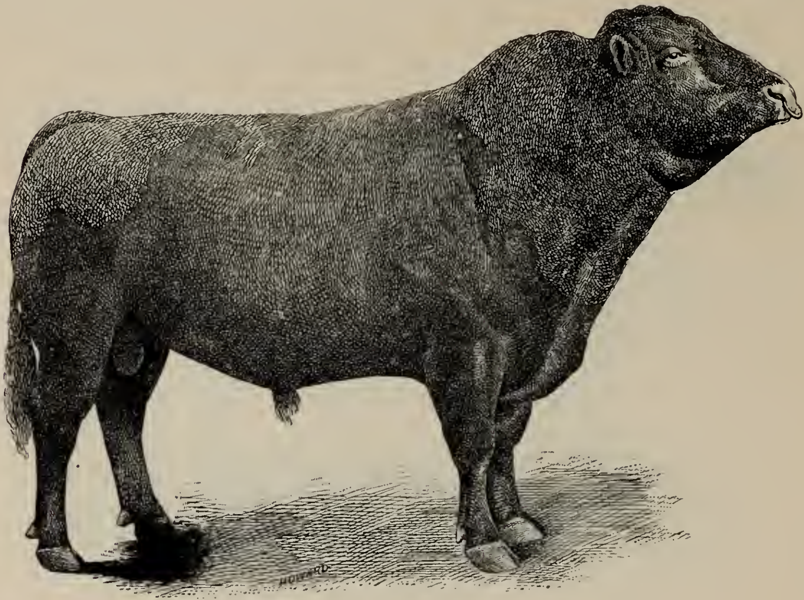


FIG. 198. RED POLLED BULL, DOBIN 3462.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

585. *Red Polled cattle* — This is one of the newer breeds of cattle, and, like most others spoken of, is of English origin. According to Wallace, the foundation stock was obtained by combining the breed of cattle originally produced in the counties of Norfolk and Suffolk. The cattle of Norfolk were a horned breed, red in color; those of Suffolk were usually dun or mouse color and polled. The original stock obtained by combining these two types produced a large proportion of excellent dairy animals, but, as

has been the case with many other breeds, the effort to improve these cattle as beef animals has resulted in sacrificing their quality for the dairy to a considerable degree. According to Wallace, Galloway bulls were crossed extensively upon the original stock. At first the breed was not uniform as to color but, according to the same authority, early in the nineteenth century certain breeders carefully collected some of the best deep blood red specimens and, by careful management combined with close breeding, succeeded in making the stock much more uniform and in making the deep red the prevailing color. Red Polled cattle of the present time show a well devel-

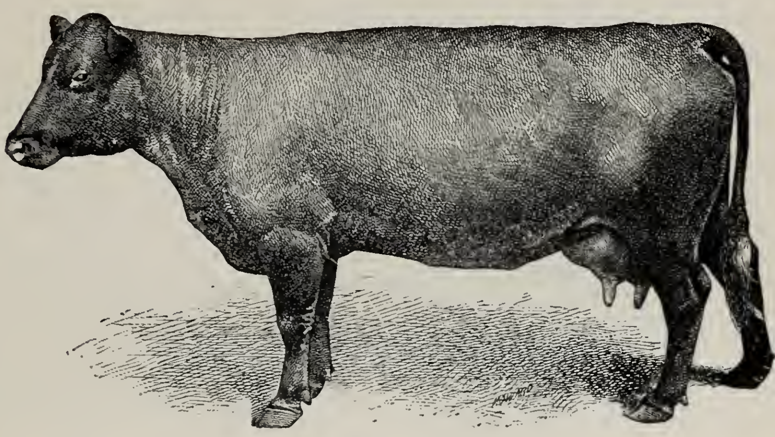


FIG. 199. RED POLLED COW, BEAUTY V. 2629.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

oped beef form, though many individuals are still good milkers. Red Polled cattle resemble the Devon about as closely as the Polled Durham resembles the Shorthorn. They are said to give somewhat more milk as a rule, but in quality the milk is not quite so rich as that of the Devon. The first important importation of Red Polled cattle which was maintained pure was made in 1873. Since that date there have been numerous importations. These cattle are more largely kept in Ohio than in any other state, but the total number in the country is as yet small as compared with most of the breeds of live stock which have been described.

586. *Simmenthal cattle* — Switzerland is the native country of the Sim-

menthal cattle, but the breed is kept to a considerable extent in other parts of Central Europe. In Switzerland the Simmenthal cattle are apparently valued largely because of their adaptation to all the purposes for which cattle are kept. They combine in unusual degree characteristics which render them valuable for the dairy, for beef, and for work. In many ways they bear a rather close resemblance to the Brown Swiss. They are large, bulls ranging between 2,200 and 2,500 pounds, cows between about 1,200 and 1,700 pounds in weight; the latter averaging probably about 1,400 pounds. The frame is strong, the muscular development powerful. The bones are heavier than in the more highly refined English beef breeds. The beef rectangle is not so perfectly developed, the whole body being more rounded. The proportion of dressed to live weight is smaller than in the best English breeds, and they do not mature as early. In color they are generally cream yellow and white in distinct patches, the proportions of the two colors varying widely, some being nearly all cream yellow, others nearly all white. In disposition they are very gentle and tractable. The cows as well as the oxen are widely used in Europe for work. The Simmenthal is a hardy breed, well adapted to subsist on coarse forage, chiefly grass and hay. In the sugar beet districts of some parts of Germany, steers of this breed are very largely imported from Switzerland and Austria. These steers are extensively used for work in these districts, while at the same time they are so liberally fed on the by-products of the beet sugar industry that they make a rapid growth. At the age of five or six years they are ready for the butcher, and the increase in value due to their growth and

FIG. 200. SIMMENTHAL COW.
From a German Work.

fattening more than covers the cost of their keep, while an enormous amount of work has been accomplished with them. For this especial use the breed is remarkably well adapted, as the oxen have great strength and are fairly active, and the beef is of excellent quality. In dairy quality the Simmenthal cattle on the average fall rather behind the Brown Swiss. There are comparatively few animals of this breed in the United States, and those have been quite recently imported. It is too early to say what the future of the breed in this country will be ; but to the author

FIG. 201. NORMANDY COW.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

it seems that, while they combine in remarkable degree characteristics which render them of value in their native country, and in some parts of Europe, they are not sufficiently highly specialized to render them favorites in the United States.

587. *Normandy cattle* — The Normandys are a French breed and are said to be very highly prized as dairy animals in their native country. Their quality as such does not, however, entitle them to rank with the highly specialized dairy breeds so widely kept in this country. They combine to a fair extent the characteristics of the beef and dairy type. But few of these animals have been imported into the United States, and such

as have been seen by the author have given him the impression that they lack uniformity of type. Within a small herd, all from a single importation, were found animals differing widely in size and form and in all general characteristics. Normandys will rank with the large breeds; bulls usually range from 1,800 to 2,000 pounds, and cows between 1,000 and 1,500 pounds. In color the breed is generally red or reddish brown and white, often brindled. The specimens seen by the author were, on the whole, rather coarse, rough looking animals. Their rough appearance is said to be due in part to the fact that in France they live for the most part in the open air, being seldom sheltered and then only in sheds. It is claimed that, as a result of their open air life in their native country, these animals have unusual constitutions. It seems hardly probable that their qualities will bring them into general favor in the United States.

588. *The common stock of the United States* — In one sense of the word there is no one common stock of cattle in the United States at the present time, nor indeed was there ever any very high degree of uniformity. Still, fifty years ago we had in this country a type of cattle generally known as natives. In the strict sense of the word these cattle of course were not natives. All our cattle are of European origin. They were natives only in the sense that they descended from an ancestry imported in the so distant past that record of importation was lost. In the New England states, these cattle were generally red and the Devon breed had perhaps exercised as great an influence as any in determining their characteristics. In other sections of the country, especially in some parts of New York and the Middle states, the blood of the Dutch stock had exercised a much greater influence. In some parts of New England, and to a greater extent in some other sections, as a rule, where the pastures were rich, Shorthorn blood had exercised a predominant influence. In some other parts of the country, particularly in the Southwest, Spanish blood was most in evidence. The so-called native stock of New England was what might be called a general purpose animal. To a certain extent this is also true of the common stock of the Middle states and of the Ohio and Mississippi valleys. This general purpose stock has now for the most part disappeared. Most farmers now use bulls of one

of the pure breeds and they have been doing so with increasing regularity for the past thirty or forty years. As a result of the use of such bulls the stock of most of the older parts of the United States has been better fitted to special uses. The kind of bulls used has differed in the different sections of the country, in accordance with the objects which the farmers had in view. Thus, Shorthorn bulls have been mainly used in the Mississippi and Ohio valleys and in the Central West ; Jerseys have been most largely used in the dairy districts, particularly in those where butter is the chief dairy product. Especially is this true in the New England and the Middle states. In certain districts of late years Guernseys are largely employed for similar purposes, while the Holstein-Friesian is selected where a large yield of milk for city or town trade is in view. In the farther West, Hereford and Aberdeen-Angus bulls have been largely used in improving the original type. This is especially true of those regions where the stock has great freedom of range and is given but little protection. In very many parts of the country, bulls of the pure breeds have been so long used that the common stock has acquired many of the characteristics of the pure breed selected. For practical uses such stock is in most cases equal to pure bred stock, though of course cattle cannot be sold for breeding purposes at as good prices as if pure. If, however, the farmer's chief object, in a dairy section, is a herd of cows which will give profitable returns at the pail for food consumed ; or, in the beef producing districts, animals that will make similar returns in beef of good quality ; then it is by no means to be considered as essential that the animals be of pure blood. Indeed, it is not infrequently the case that animals of pure blood have lost somewhat in constitution ; and that they breed somewhat less certainly as a result of the conditions under which they have been kept and bred. Not by any means every animal which has a long pedigree and which is registered is valuable. So long as the numbers of animals of the different pure breeds in this country were comparatively small, there was a great temptation to keep and use for breeding purposes all individuals whether they possessed valuable characteristics or not. We accordingly find, as might be expected, numerous very poor individuals in almost all of the pure breeds. The best course for the common farmer

who does not aim to produce stock for sale at fancy prices, but is simply looking for a product, is as a rule to keep grade animals, selecting such as have been bred in lines suited to his requirements: Jersey or Guernsey grades where butter is the object; Ayrshire or Holstein-Friesian grades where milk is the object; Shorthorn, Hereford, or Aberdeen-Angus grades where beef is the object. It will usually be advisable for such farmers, however, to place at the head of their herds a bull of a pure breed, and of superior qualities as an individual.

LXXXVI — HORSES (*Equus caballus*).

589. *Origin of domestic horses* — It is believed that all the various breeds of domestic horses, ponies being included in this general term, are descended from one parent stock. Between the ponderous draft horse and the Shetland pony hardly so large as a St. Bernard dog, we find exceedingly wide variations; but these are all accounted for by the widely differing conditions under which horses have been kept in different localities and in the hands of different breeders. Geologists tell us that the ancestors of the horse were indigenous to the United States, but the species became extinct upon this continent previous to its discovery by the white man. It is not certainly known from what wild species domestic horses sprang. Most of the horses of the United States are the descendants of animals imported into this country from Europe. There have been occasional small importations of horses of the Arabian type from Africa or Asia, but such importations in this country have exercised but little influence upon the characteristics of our horses. Only those breeds which are of some importance in this country will be described.

590. *The breeds of horses classified* — All the breeds of horses which will be here considered may be included under the following classes: horses valued especially for high speed (this class including both race and trotting horses), draft horses, general purpose horses (including all the so-called carriage and coach breeds which, although kept mainly for driving, are of considerable value also for heavy work), and ponies.

591. *Parts of the animal named* — In order that what follows concern-

ing the peculiarities of the different breeds may be perfectly understood, a cut showing the names of the different parts of the external anatomy is presented.

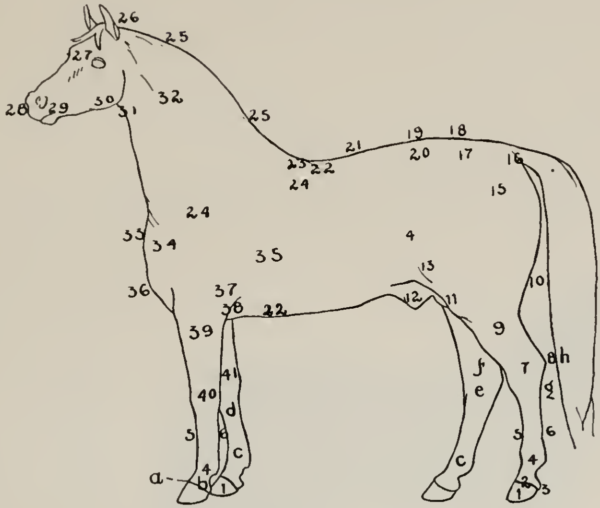


FIG. 202. HORSE SHOWING POINTS.

1. Hoof.
2. Coronet.
3. Heel.
4. Fetlock or pastern joint.
   (*b*) The pastern.
5. Canon bone.
6. Back sinew or tendon.
7. The hock.
8. Point of hock.
9. Second thigh.
10. Haunch, or lower buttocks.

10 to 20. The quarter.

11. The stifle.
12. The sheath.

13, 14. The flank.

15. The hip joint.
16. Root of tail.
17. The rump.
18. The croup.
19. The loins.
21. The back.

22, 22. Girth, or chest measurement.

23. Withers.

24, 24. Shoulder blade.

25, 25. The crest.

26. The poll.
27. The forehead.
28. The muzzle.
29. The nostril.
30. The jaw.
31. The throat or windpipe.
32. The neck.
33. Point of shoulder.
34. Shoulder.

35 to 14. Front ribs and back, or short, rib forming the barrel.

36. The chest or breast.

37 to 34. The true arm.

38. The elbow.
39. Arm (so-called) or forearm.
40. The knee.
41. The chestnut.

592. *The ideal horse* — While horses valued for the different purposes for which these animals are used must, of course, differ in certain important particulars, there are many points connected with the form and structure of the horse, and of his different parts, which should be nearly alike for all breeds. It seems desirable, at the outset, to endeavor to give a clear idea as to what this ideal type is. In connection with this description the student is advised to refer constantly to the portrait.

The head — The volume of the brain undoubtedly determines the courage and other mental qualities of the individual, hence the forehead, the seat of the brain, should be broad and full. The muzzle should be fine, the lips firm, the nostrils large and open. There should be a wide space between the two sides of the jaw to afford ample room for the windpipe. This width of jaw is desirable, moreover, in order that the head may be nicely and gracefully carried on the neck. If the jaw is narrow the head will be straightly and inelegantly set, the nose will be carried too far forward, the mouth will become hard to the bit, since the head cannot be bent in.

FIG. 203. STANDARD TROTTING STALLION, GAMBONITO.
From Report Com. on Live Stock, Columbian Exposition.

The *eye* should be carefully examined, for it is the index to temper and must of course be sound, and upon its freedom from defects or weakness of all sorts the value of the horse largely depends. The habit of shying is not infrequently connected with defective vision. The eye should be full, clear, and bright, but with soft and yet not dull appearance. Such an eye indicates a pleasant temper.

The *ears* should be of medium length, set wide apart, erect, and active. The spirited horse is interested in everything that goes on about him and quickly turns the ear, now this way and now that, to catch every sound. If the ear is inactive the horse has generally a sluggish disposition.

The *neck* should be of moderate length, full and muscular where it springs from the body, but gradually tapering toward the head, which it should join with a graceful curve.

The *fore quarter* — The shoulder blade and the true arm should be long, to give abundant room for the attachment of powerful muscles. An oblique shoulder is required for horses from which high speed is expected. Length of stride is favored by an oblique shoulder, also ease and springiness of motion. The shoulder of the draft horse should be more upright, as this conformation affords a better surface upon which the collar can rest. The shoulder point should be well developed but not showing any roughness. The elbow should not lie too close to the ribs. There should be space between the elbow and the ribs for easy insertion of the open hand. If the elbow is too close to the ribs, the motion of the fore legs is not sufficiently free. The forearm should be long and muscular, especially in all horses of which high speed is expected. The long forearm gives capacity for strong and sweeping action. The knee should be broad and flat when looked at from the front, broader than the leg either above or below. It should taper off upwards to a comparatively thin edge. The leg immediately below the knee should be as large as in any other part between the knee and the fetlock. The bending of the knee backward causes the formation known as "calf knee." This is neither uncommon nor very much objected to in draft horses if not excessive, but is apt to lead to sprains in race horses. A knee naturally bending somewhat forward is preferred, but too much bending in this direction, especially if the result of overwork, is objectionable.

The *canon bone* should be flat and large, firm and solid in its texture. The ligaments and back sinews should be strong, clean, firm, and free, *i. e.*, they should not lie too close to the bone. They should stand somewhat away from it. In legs of the very best type strong pressure between the muscles and the canon bone will enable one to bring the tips of the thumb

and fingers almost together, two thicknesses of skin simply separating them.

The *fetlock joint* should be of good size, clean, *i. e.*, free from all superfluous tissues. It should be hard and firm, the skin closely drawn over the bones.

The *pastern* should form an angle of from about 45° to 60° with the ground.

The *hoof* must be well rounded and form a moderate angle with the ground in front.

The *withers* should be high and, in horses for speed, thin at the top.

The *chest* must have capacity, as it is not only the measure of the power of the lungs, but also of the size and the power of the organs of digestion. In draft horses the chest is wide but in the road horse or trotter capacity should be obtained by depth rather than width.

The depth of the back ribs is an evidence of stamina, and hence desirable.

A short back with a body long underneath is the shape most esteemed. The measurement from the shoulder point to the back of the quarter should be somewhat greater than the height at the withers, otherwise the action is confined, especially in the gallop, as the hind legs cannot be brought forward sufficiently. The ribs should extend well back, leaving only a narrow space between the last one and the hips. When this space between the last rib and the hip is narrow, the animal is said to be "well ribbed up." The upper line of the back should bend down a little at the withers and then swell out gradually to the junction at the loins, which can scarcely be too broad. The hips should be wide apart, the loin slightly arched to give strength.

Hind quarters — The shape of the parts of the hind quarters varies much in different breeds. In those for speed both the quarters and the thigh must be long. In the draft horse the thigh is shorter and more upright. The quarters should be full and muscular in all breeds. They should come close together, leaving no hollow below the anus. A horse having such a hollow when in good condition is almost sure to lack constitution.

The *hock* is a point which should be carefully examined. It should be

large, firm, entirely free from all softness and bunches, and in horses for speed it should be comparatively near the ground, thus insuring a short canon bone in the hind limbs.

LXXXVII — BREEDS OF HORSES VALUABLE FOR THEIR SPEED.

593. *The Arabian horse* — Although the Arabian horse is not of much importance in this country, it is mentioned first because to the horses of Arabia and to those of similar type in adjacent countries in the Orient was due in very large measure the great improvement effected in establishing most of the important breeds of to-day. To the horses of the Orient most of the breeds of horses of to-day owe in very large measure compact bone and muscle, intelligence, spirit, and endurance. The original excellence of the Arabian horses appears to be due chiefly to the following causes: —

1st. The dry air and soil of the country favorable to the development of horses with firm, hard bones, sinews, and muscles as well as with good feet.

2d. The love of the people for horses and the consequent great care exercised in their breeding and general management.

3d. The free and roving life of these people, who are still in many cases nomads, this life assuring the abundant exercise essential to full development of the most favorable characteristics.

At the present time Arabian horses are surpassed in size and speed by the horses of some of the breeds which originally owed most to them. With the Mohammedan races which have bred them, the oriental horses have probably suffered some deterioration. Even at the present time, however, the Arabian horse is remarkable for width of forehead, fine muzzle, dishing face, full, soft eye, finely arched neck, oblique and muscular shoulders, small but very strong feet, large joints, intelligence, docility, and spirit. The withers are moderately high and thin, the chest is rather light in girth but the back ribs are deep, the hip is apt to be rather narrow but the loin is well rounded and powerful. The croup is high. The legs are very large in proportion to the size of the animal. The legs are thin when looked at from in front or from the rear, broad when looked at from the side. These

horses have great constitution, ability to endure rough usage, and to subsist upon the plainest food. Arabians are not maintained as a pure breed in the United States at the present time.

594. *The Thoroughbred horse* — There has been some confusion in the use of the word Thoroughbred as applied to live stock. The expression is not infrequently used by those who intend to convey the idea that the animal is pure bred. The term Thoroughbred as applied to horses is a breed name just as the terms Percheron and Clydesdale are breed names. The Thoroughbred is an English breed of horses, but animals of this breed were early imported into the United States and they are quite largely kept here. They are, however, of chief interest to most of us because of the relation of the breed to American Trotting horses. It is certain that Thoroughbred horses contain much Eastern blood. Just how much is a debated point. Some hold that the Thoroughbred must be traced back to Eastern blood on the side of both sire and dam, others maintain that the horses of this breed contain much of the blood of the common native horse of England, the breed having been formed by crossing this with Arabian and other oriental horses. Whatever the truth may be as regards the proportion of oriental blood, it is certainly true that the Thoroughbred owes many of its valuable characteristics to that breed ; among others, fine head, hard, muscular legs, spirit, endurance, and speed. In general formation the Thoroughbred approaches closely to the so-called ideal type of the horse which has been given. His chest is unusually deep, the cross section

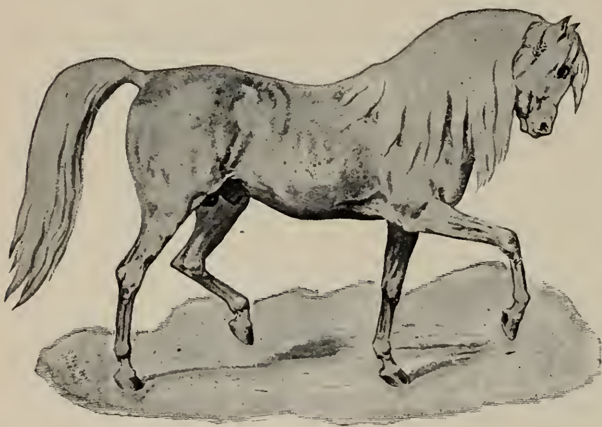


FIG. 204. ARABIAN STALLION, HUSSIN.
After Dunham.

behind the shoulders is an ellipse. A chest of this form in the horse is more favorable to free lung action than the round chest. When the horse breathes deeply at high speed the ellipse broadens and the lungs thus have room to expand. The bones of the legs in both the fore and the hind quarters are small, while the ligaments and sinews stand out so far and are so large as to appear to constitute fully one-half of the leg. The legs and fetlock joints are free from long hairs ; the mane and tail are light. The skin is thin and the veins prominent. The coat is soft and fine, the hair short. In color there is much variation ; bay, chestnut, and brown in the order named are most common. Gray and black are occasionally seen.

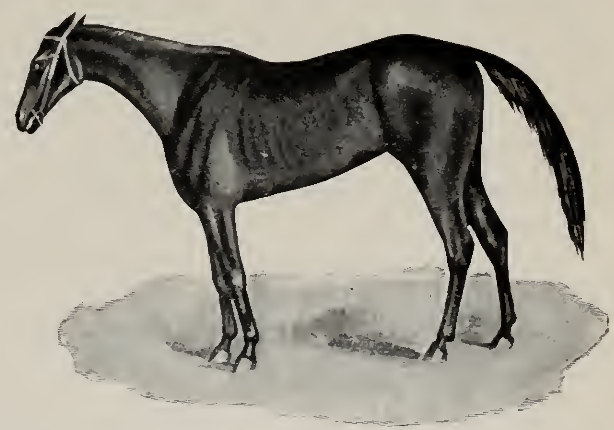


Fig. 205. Thoroughbred Mare, Black Maria, an Animal of Great Speed and Endurance.
After Forester.

It is a clearly established fact that in the Thoroughbred the blood circulates more rapidly than in horses of most other breeds, and this is considered a most valuable characteristic since it gives energy and recuperative power. There is much difference between the Thoroughbred and most other breeds in nervous organization. The Thoroughbred is bold, fearless, ambitious, full of life and energy, and, with the ambition to do all things, he has the ability in his powerful lungs and well-developed bony, muscular, circulatory, and nervous systems. The Thoroughbred of the best type has remarkable endurance, being able to travel on the run farther and faster than animals of any other breed. Thoroughbred horses are much used in England as hunters and riding horses. They are used to a considerable extent in this country for similar purposes, but both in England and in this country they are very largely bred and kept for racing purposes.

595. *American Trotting and Roadster horses** — It can as yet hardly be claimed that American Trotting horses constitute a distinct breed. That we have better trotting horses in this country than in any other will be everywhere admitted. The development of horses of this type appears to be due primarily to the fondness of the American people for driving on the road. For this purpose fast and stout horses are needed. As a means of testing these horses, public trials of speed at the trot have been growing increasingly common for nearly one hundred years. A number of rather distinct families in American Trotting horses are recognized. All of these owe very much to the Thoroughbred — more to imported Messenger than to any other single animal. Mingled with the blood of the Thoroughbred there is more or less of the blood of the common stock of the country, but with the lapse of time the proportion of Thoroughbred blood becomes constantly greater and in the most important respects the American Trotting horse closely resembles the Thoroughbred, save that he is bred and trained for high speed at a trot, while his Thoroughbred ancestor is distinguished only for speed on the run.

According to Sanders the most important families of American trotters are the following: —

1st. Hambletonians. Hambletonians descended on the paternal side from imported Messenger. Rysdyk's Hambletonian, the horse which gives the name to the breed, was a great-grandson of Messenger, foaled in 1849, and kept for breeding in Orange county, New York, until 1876.

2d. Mambrinos. Mambrino also was a great-grandson of imported Messenger. He was used for breeding purposes mainly in Kentucky with Thoroughbred mares and from him are descended many of the fastest animals.

3d. Clays. These are descended from the famous trotting stallion, Henry Clay, foaled in 1837. This stallion also was related to imported Messenger, but on the maternal side.

4th. Morgans. These are descended in the paternal line from a horse called Justin Morgan, foaled in 1793. The Morgans will be specially spoken

* See Fig. 203.

of because of their unusual value as carriage and general purpose horses. Many very fast trotters contain Morgan blood ; but this family is not so highly prized at the present time as others, by those who place speed above all other qualities. Justin Morgan is believed to have had a large share of Thoroughbred blood.

5th. Bashaws. Bashaws are very closely related to the Clays and through them to Messenger.

6th. Pilots. This family of trotters takes its name from the old black pacer Pilot, who was of French Canadian ancestry. This blood mingled with the best trotting strains has produced many very fast animals.

The American Trotting horse shows most of the peculiarities of disposition which have been spoken of as belonging to the Thoroughbred. Many of them are good drivers, especially with light carriages, but it must be admitted that in many instances trotting bred horses are too nervous, too high strung, to be satisfactory for general use as carriage animals. There can be little doubt that by selection a very superior type of the driving horse can be produced from the American trotter. These horses have the speed, the ambition, needed in the driver. The trotter is, however, somewhat too highly organized, too much specialized, requires too great care, to be wholly satisfactory for general use. There is no such thing as fixity of type among American trotters. We find in general, however, the head, neck, withers, and legs of the Thoroughbred, his thin skin and prominent veins, and the elliptical chest. All colors are represented though bay is without doubt most common.

596. *The Morgan horse* — As has been stated, Sanders includes the Morgan among the families of American trotters. This breed without doubt deserves a place among those families, but the Morgan horse is much more than a family of trotters. Justin Morgan, the ancestor of the breed, was foaled in Massachusetts, but was kept in Vermont the greater part of his life. The following description of Justin Morgan is an abbreviation of that by Linsley, who is the best authority on the early history of the Morgan horse : —

"Height fourteen hands, weight 950 pounds, color dark bay with black

legs, mane, and tail. Mane and tail rather coarse and heavy, hair of both straight, head good, of medium size, lean and bony ; face straight, forehead broad, ears fine and set wide apart ; eyes of medium size and very dark and prominent ; nostrils large ; muzzle fine, lips close and firm. His back and legs were perhaps his most noticeable points. The former was very short, the shoulder blades and thigh bones very long and oblique, loins exceedingly long and muscular, body rather long, round, and deep, well ribbed up ; chest wide and deep with the breast bone projecting a good deal in front ; legs short, close jointed, thin but very wide, hard and free from fat, with muscles remarkably large for a horse of his size. This superabundance of muscle manifested itself at every step. Hair short and at almost all seasons soft and glossy, a little long hair on the fetlocks and for two or three inches above on the legs. Feet small but well shaped. He was in every respect sound ; a fast walker ; in trotting his gait was low and smooth ; step short and nervous. He was not what in these days would be called fast. It is doubtful whether he could trot a mile in less than four minutes though some claim he could trot that distance in three minutes. Though he raised his feet but little he never stumbled. His proud, bold, fearless style of movement and his vigorous action have perhaps never been surpassed." Justin Morgan was an animal of great constitution. He was used for breeding purposes until he was twenty-eight years of age and came to his death as the result of an injury. Several of his immediate

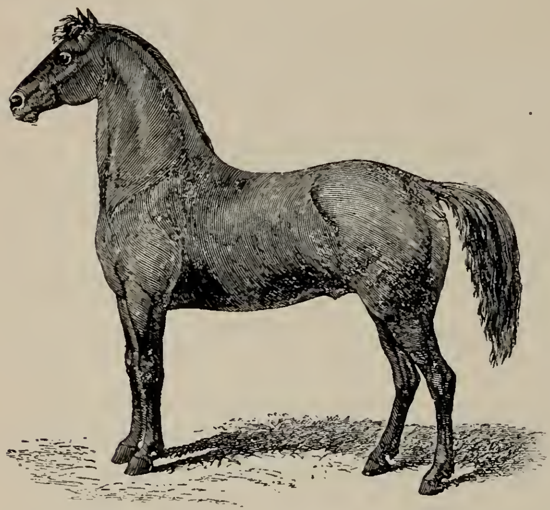


Fig. 206. Justin Morgan, the Founder of the Morgan Breed. *After Linsley.*

descendants were used for breeding for over thirty years. The value of Justin Morgan was not at first appreciated although he was known to be a remarkably fine animal. The stock first began to be appreciated when it was found that Justin Morgan and many of his sons possessed that inestimably valuable characteristic of stamping their likeness upon their offspring to a remarkable degree. From Justin Morgan descended a type of horse resembling the sire in most important particulars ; though in later years, as a rule, larger. Perhaps 1,000 to 1,050 pounds is nearly the average weight. Morgans were remarkable for endurance, capacity to do an enormous amount of work whether on the road or in the field, with ordinary food, care, and shelter. These characteristics rendered them great favorites with livery stable keepers and horse railroad managers. Sanders says* : "Go where you will among livery stable keepers and horse railroad managers, and ask what type of horse they have found most profitable to use and wear out on the road, and the almost invariable answer will be, 'The old-fashioned Morgan.'" The writer a few years since in Boston saw on exhibition a Morgan horse, at that time forty years of age, concerning which the West End Street Railway Company gave this information : "This horse was for twenty-five consecutive years in continuous service on the street railway lines of this company. During all this time he never lost a trip and it has been computed that he has traveled in the service of the company 125,000 miles, or more than five times around the globe. We have now placed him in honorable retirement and shall support him in comfort and luxury for the rest of his natural life." The animal appeared even then to be sound and vigorous.

It will not be denied that the characteristics which enable a horse to make such a record as this must be among the most valuable, and the testimony of thousands of men could readily be obtained to the fact that Morgans are among the most satisfactory for general road work, and the lighter farm work. Notwithstanding these facts so generally admitted, the tendency to place the highest speed above all other qualities caused the Morgan to fall into temporary obscurity. Within the last few years an at-

* "The Breeds of Live Stock."

tempt is being made to breed Morgans as a pure stock. An association of breeders has been formed and it is hoped that their efforts may be successful.

597. *The American Saddle horse* — The American Saddle horse is a comparatively modern breed. It is possibly not with entire propriety included in this class as it is valued for beauty and comfortable gaits under the saddle even more than for speed. It has derived a large share of its blood, however, from the English Thoroughbred and is in many particulars similar in type to that breed. Curtis says*: "In appearance the typical Saddle horse is a combination of Thoroughbred and Trotter, having the size, gameness, and easy, clean-going action of the former, with the quiet, intelligent appreciation of education at the trainer's hand which we find so marked among the Trotters." This breed is of most importance in Kentucky and farther south.

598. *Orloff Trotters* — The breed of Orloff Trotters takes its name from Count Orloff of Russia, by whom the breed was originated. Early in his efforts to improve the trotting horses of his native country, Count Orloff imported a gray stallion of great size and strength from Arabia. This stallion was called Smetanxa. The union of Smetanxa and a Danish mare produced Polkan First. Polkan First bred to a Dutch mare produced a stallion, Bars First, and this stallion, according to Sanders, is generally regarded as the progenitor of the Orloff Trotters. Orloff Trotters are not regarded as equal in speed or endurance to American Trotters, and not many of them have ever been imported into the United States. There is a general feeling that it may sometime be found an advantage to cross this blood with the blood of the American Trotting horse, in order to restore a possible loss of vigor which may be the result of the close breeding so often practiced in this country. Up to the present time, however, nothing of importance in this direction has been done and the Orloff Trotters may be dismissed as having no present prominence in the United States.

*"Horses, Cattle, Sheep, and Swine," Curtis.

LXXXVIII — DRAFT HORSES.

599. *General characteristics of draft horses* — The draft horse differs from the ideal type, which has been described, chiefly in the following respects. The size is greater, the whole body is thicker and heavier, the shoulder is thicker and more upright, the legs relatively shorter, a section through the body behind the shoulder would be much more nearly a circle in outline than a similar section through the body of the horse valuable largely for speed, the ribs spring out from the backbone relatively much more broadly, the back is wide, the rump not infrequently slopes more than in the horse prized mostly for speed, the head is relatively shorter and thicker. It will be seen that in many respects the draft horse differs from the horse kept for speed as does the beef type among cattle from the dairy type. All the largest breeds of draft horses we are to speak of derived their size for the most part from the same source, all containing the blood of the large, heavy horse common to the rich lowlands of Flanders. This old Flemish breed was exceedingly sluggish in temperament as well as heavy and somewhat coarse in structure. It has been improved in a number of the modern breeds of draft horses by the infusion of the blood of smaller and more refined animals.

600. *The Percheron horse* — The breed takes its name from the Province of Perche in Northern France. It is descended from the old Norman horse crossed with horses which came from the Orient through Spain. From the old Norman the Percherons take size, constitution, and to some extent form ; while from the oriental horse they take spirit and activity. Concerning the blood of the Percheron, Sanders says * : —

"There is every reason to believe that the Percheron, like the draft breeds of England and Scotland, derived its size originally from the large Black horse breed of Flanders ; but from the fact that gray has for many generations been the prevailing color, it is evident that some very powerful agency has been at work, modifying the type until it has but little in common with this old parent stock, except size ; and this agency has undoubtedly been the large admixture of the blood of the Arab, and from this

* "The Breeds of Live Stock."

source the prevailing gray color is derived. Aside from the history and traditions of the country, the Percheron horse himself furnishes unmistakable evidence, in his form, disposition, color, and general characteristics, that he is closely allied to the Arab."

Percheron horses were early especially noted for their ability to move a heavy load at a rapid gait. Before the days of railroads they were largely employed upon the diligences and stagecoaches in their native country. They differ considerably in size Many of those imported into this country are of the very largest type, and these appear to have suffered a loss of some of the activity for which the breed was originally noted. Percherons, as represented in the United States, vary in weight from about 1,500 to 2,000 pounds or more for stallions, and from 1,200 to 1,500 pounds or more for mares. The color is most frequently a dapple gray, which may be quite dark when the horse is young, but which may become white as the animal grows older. They are sometimes black and in this country black is a favorite color. The legs and feet of the Percheron are remarkable for soundness. It is claimed that they are far less likely to become diseased than are the legs and feet of the heavy draft horses of other countries. The legs have a little long hair, but much less than some of the other draft breeds.

FIG. 207. PERCHERON STALLION, BRILLIANT.
The most famous Percheron Stallion of the Century.

Other names were frequently applied to horses of this breed when they were first imported, but after the establishment of the Percheron stud book

in France, the name Percheron was adopted by American breeders and is now the only one recognized.

Many Percherons have been imported and bred in the United States. This breed and the Clydesdale stand first in numbers among heavy draft horses,— the Clydesdale perhaps leading, the prevailing bay color and reputation for faster walking of the latter breed appearing to give it an advantage. The superior quality of the Percheron is without doubt in considerable measure due to the wisdom of the French Government, which for a long time has exercised direct control over the selection of sires, offered bounties for the keeping of approved animals, and maintained government studs where horses of the very highest type have been bred, and, at nominal figures, offered for the use of the private farmers (607).

601. *French draft horses* — The term "French Draft" applied to horses is a comprehensive one. It may and does include in some cases the Percheron, but it includes also other types of draft horses from France which would not be admitted to registry as Percherons. From what has been said it will be understood that there is less uniformity among the horses known as French Draft than in most breeds. Among horses so known, however, are many excellent animals. Their origin is in many respects the same as that of the Percheron, though there is not as much Arabian blood as in the latter breed ; indeed, it may be that not all of the French draft horses contain any of that blood. There is greater diversity in regard to color, as well as in regard to size and form, among French draft horses than among Percherons. They are in general characterized by similar qualities. They are less numerous in this country than the Percheron.

602. *The English Shire horse* — The English Shire is without doubt, on the average, the heaviest breed of horses in the world. Its blood was drawn primarily from Northern Europe, large numbers of the great Black horses of Flanders having been imported in the days when knights fought in armor, and ponderous horses were needed to carry the enormous weight. Both mares and stallions were imported in large numbers, but it is not claimed that the purity of this original stock was maintained. It was more or less crossed with the common stock of the country. The importation

of this foundation stock took place chiefly some seven or eight hundred years ago. In modern times, in the effort to improve the breed in certain particulars, there have been many importations from the continent of Europe. Bakewell, mentioned in connection with Longhorns (579), was prominent in this work, going himself to Holland for the selection of animals to cross with such as he found at home. In the earlier history of the breed the color was usually black; the horses were of immense size, with great strength, but were heavy, dull, and sluggish in temperament and slow and awkward in motion. Professor Low, in his "Domestic Animals of the British Islands," says:—

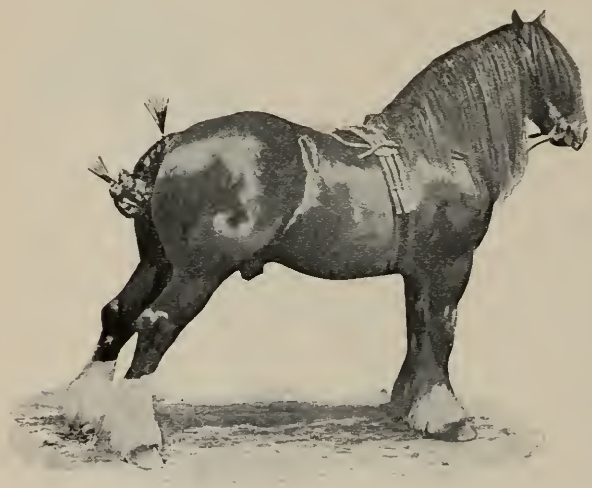


Fig. 208. Shire Stallion, Staunton Hero. *After Wallace.*

"The Modern English Black horse retains the general characteristics of the pre-existing race, but greatly modified. His color is usually a sooty black, with frequently a white lozenge-shaped mark on the forehead; and he has very generally one or more of the feet and part of the legs, and not unfrequently the muzzle, white. His body is massive, compact, and round; his limbs are stout, his chest is enormously broad, and his neck and back are short. His mane is thick and somewhat frizzled, and his legs below the knee and hock are hairy down to the heels. His whole aspect conveys the idea of great physical power without corresponding action. The main defects of his conformation and temperament are his too great bulk of body and want of action and mettle. For a pull with a heavy weight he is admirable; but he steps out short, and is slow in all his motions."

At the present time these horses are of all colors, black, bay, and brown predominating. They are frequently marked with more or less white on the feet. The legs are heavily haired or "feathered" as Shire horse breeders express it. An abundance of fine, silky hair from knee and hock to the fetlock is considered a mark of pure breeding. Shire horses have not been as largely imported in the United States as either Clydesdale or Percherons. They are increasing in popularity in the great agricultural states of the Mississippi valley, but it seems to the writer improbable that this breed will ever supplant the Clydesdale to any considerable degree.

603. *Clydesdale horses* — The Clydesdale is a Scotch breed. In size it is somewhat inferior to the Shire horse, but it still ranks as a large breed. It owes its large size to the same foundation stock as the Shire horse. The following description of the Clydesdale is condensed from Wallace* : —

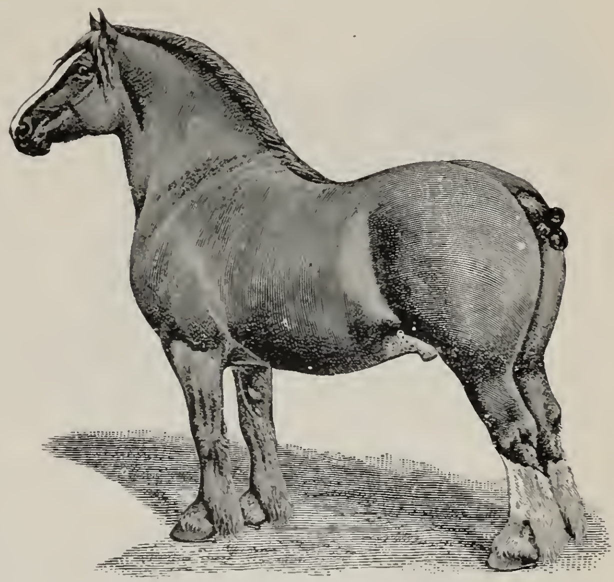


FIG. 209. CLYDESDALE STALLION, MCQUEEN.
From Report Com. on Live Stock, Columbian Exposition.

"Color usually bay or dark brown, often with white in the face ; height averages from about 16 to 16½ hands ; temper is mild with plenty of nervous energy ; head of medium size ; face straight and slightly arched — not dished; neck medium length and thickness, slightly arched in the male and also in the female when in high condition ; back straight and broad and not so long as to make it weak ; ribs well sprung, the last one of good length ; hind

* "Farm Live Stock of Great Britain."

quarters long, well rounded ; body deep ; chest broad and deep ; shoulders moderately oblique ; fore legs straight, strong, not too far back under the body ; knee and hock joints large ; muscle of the arm broad and well developed ; bones in both fore and hind legs short, flat, and clean ; feathering fine, long, and silky. White feet, though common, are objectionable because softer than the dark, though some authorities go so far as to say that a white foot is an essential for a Clydesdale. The foot cannot be too large if not thin and flat. Pasterns medium length, if long they are weak ; action free and active ; step long, the animal walking when unloaded four miles an hour. Young horses at times surpass this rate, but for an ordinary work horse it is quite quick enough. The sole of the foot should be almost inverted each time it is lifted, either in trotting or in walking.

Fig. 210. Suffolk Punch Stallion, Queen's Diadem.
After Wallace.

As remarked in the comparison made with the Percheron, it is the naturally fast walk and the color of the Clydesdale which render it a favorite in the United States among the draft breeds. On this point Curtis says * : —

"The American farmer is not slow to appreciate the superior value of a team that will plow three acres of ground in a day, as against one that with the same plow will turn but two acres, and this fact has done much to advance the interests of the Clydesdales in America."

604. *Suffolk Punch* — This breed of horses, although a prime favorite among the English farmers, is not as well known in the United States as

* "Horses, Cattle, Sheep, and Swine."

the other English draft breeds. It is not quite as large as the Clydesdale. The origin is not certainly known but it is believed that Norman stallions were used on the best mares of the county of Suffolk, from which the breed takes its name. The color is almost invariably chestnut or sorrel. The body is round, close, and compact; the legs short and free from long hair, which characterizes the Shire and Clydesdale. Concerning this breed Wallace says: "The body looks much too heavy for the limbs, the back is at times hollow, but this allows of a finer style of neck and shoulder. Suffolks are slower in their movements than Clydes. They are steady pullers and suited alike to farm and dray work."

605. *The Belgian draft horse* — This is a very large breed of draft horses, deriving its blood from the foundation stock so frequently mentioned in speaking of draft horses. It has been brought to a very high degree of perfection in its native country, and it is in unusually high favor throughout North and Central Europe. In size they average somewhat larger than the Percheron, the usual range in weight for stallions being from 1,650 to 2,000 pounds. The color is generally black or brown, but sorrel, roan, and other colors frequently occur. They are said to average somewhat more compact and blocky in form than the Percheron, but they resemble that breed closely in many respects save in the somewhat greater size and different color. The breed has been imported into the United States but is not yet very generally kept.

LXXXIX — CARRIAGE AND COACH BREEDS.

606. *General characteristics of carriage and coach horses* — Those breeds which are properly included in this class, also sometimes known as heavy harness horses, are in some particulars rather intermediate in their characteristics between the Thoroughbred and the draft horse type. They approach much more nearly to the type of the horse valued for speed than the draft horse type. They, however, have greater size and considerable more substance. The horses which belong to the breeds in this class must have the ability to draw a heavy carriage at a fair rate of speed. They must also present a stylish appearance, and to this end high knee action is re-

garded as important, though this peculiarity is much more developed in some of the breeds than in others. In disposition these horses should be tractable and gentle, but they must withal be spirited. Horses of this type have for many years been in great favor and the supply has hardly equaled the demand. If there is any breed of horses that can be profitably bred and reared by the ordinary farmer of New England, who has a liking for horseflesh, it is without doubt horses of this type. The breeding of trotting horses is something which only a specialist should engage in. It may be profitable under the right management, but to develop a trotting horse requires more attention to training and exercise than the ordinary farmer will be ready to give, and a horse of the trotting breed, unless remarkably fast, is not likely to be in active demand. He is too light and nervous to make him useful on the farm or for general driving. Not so the heavy harness horse. He can be made good use of at home if not sold. The chances are that if the farmer breeds fairly good mares to a good coach stallion the offspring will sell at profitable prices.

607. *The French Coach horse* — The French Coach horse contains a very large proportion of the blood of the Arabian. This blood has been obtained both by direct crossing with imported Arabian stallions and by crossing with English Thoroughbreds, which, it will be remembered (594), derived a large share of their blood from the Orient. These stallions were at first crossed upon the native French stock, but by crossing and recrossing again and again the proportion of the original French blood has finally become very small. The French Coach horses may be regarded as chiefly of oriental blood. It is said that the first decided impetus toward improvement of this breed of horses was due to the influence of Louis XIV, and that after the accession of Napoleon a still more decided impulse was given to fine horse breeding in France. In the production of French Coach horses the government has exercised an important influence. This influence has been used to promote the improvement of other breeds as well; but a large share of attention has been devoted to the improvement of the French Coach breed. Since 1870 the supervision of the government studs has been vested in the Department of Agriculture and Commerce. In 1887

the government owned 2,460 stallions, of which no less than 1,728 were of the Coach blood. These stallions are placed at the service of the private farmers at nominal fees. But the work of the government does not stop here. It has established a system of inspection of all stallions owned by private individuals that it is proposed to offer to the public for breeding purposes. Only stallions of high excellence are allowed to be so used. These are placed in two classes: first, "approved" stallions. These, so long as they are kept in service, receive an annual bonus from the government amounting to from about $75 to $150, according to their breeding and their quality; second, "authorized" stallions. These are animals which are pronounced of good quality and worthy of public patronage, but are not regarded as sufficiently good to deserve a bounty. It is forbidden by law to use for public service any stallion not authorized by the government. The French stud book for this breed was established in 1833. From a short time previous to this date there has been a regularly organized system of testing the speed of these horses. In order to remove the temptation to sacrifice size to speed, a turf law was enacted excluding all horses from public races that were less than 15¼ hands high. The French races are all for long distances, not less than two miles for young horses and from that up to three miles or more for mature horses. The French Coach horses are all speeded under the saddle and always upon a sod track. In

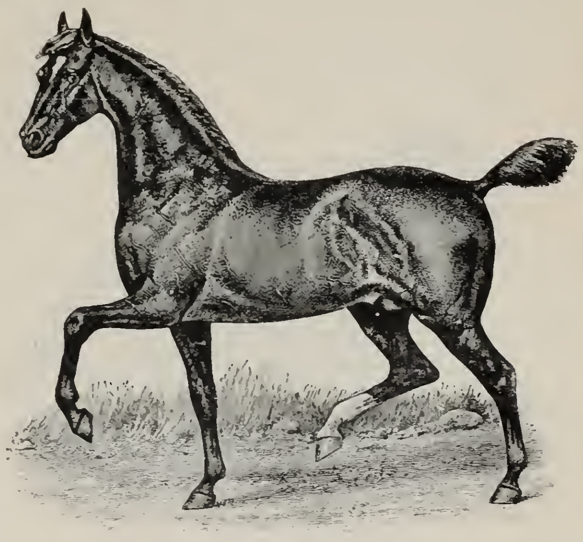


FIG. 211. FRENCH COACH STALLION, INDRE.
From Report Com. on Live Stock, Columbian Exposition.

answer to the question why they trot their horses on the sod, the French say: "Because it necessitates a high, round knee action, the only truly beautiful movement for a carriage horse; also that high step shortens the stride,—speed must therefore be obtained by quicker movement." This style of action must be regarded as perfection in a carriage horse.

French Coach horses are not what in this country would be regarded as fast. The usual time for races varying in length from two to three and three-fourths miles is somewhat under 3 minutes per mile, while the best horses make a mile in the races of these lengths in about 2 minutes 40 seconds.

The usual weight of the French Coach horse is from about 1,100 to 1,200 pounds. The most common colors are bay, chestnut, and sorrel. They are characterized by a fair rate of speed and great endurance. The best horses of this breed appear to fill the demand for fashionable driving horses in size, style, symmetry, and action, while they have the endurance and the speed to make them valuable road horses under all conditions. They have the power to transmit their characteristics in marked degree. Many of them have been imported into the United States and they are now quite extensively bred in various parts of this country.

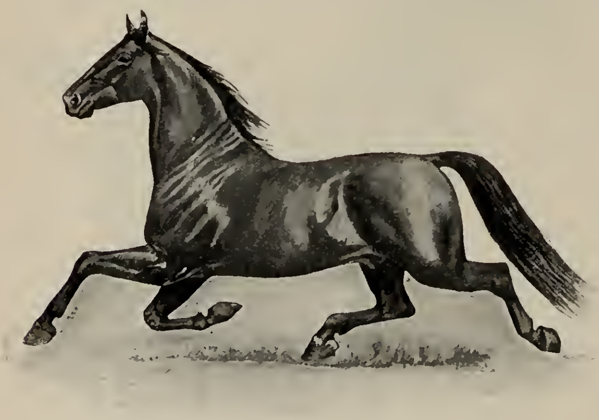


Fig. 212. Cleveland Bay Stallion, Highcliffe.
From Report Com. on Live Stock, Columbian Exposition.

608. *Cleveland Bay horse*—The Cleveland Bay is an English breed, taking its name from a district in Yorkshire, England, where it is bred in the highest perfection. The origin of the Cleveland Bay is similar in many respects to that of the French Coach, save that the mares in the foundation

stock were different. Thoroughbred stallions have been largely used in refining the breed, being usually crossed upon large bay mares. In color this breed is one of the most uniform. In size it is somewhat larger than the French Coach. It is a breed of much value for heavy carriage work, but is less generally known in this country than some of the other heavy carriage breeds. The color is almost invariably a bright bay with black mane and tail and black points. The height is from about 16 to 16¾ hands, weight 1,100 to 1,300 pounds. The Cleveland Bay is heavy enough for all ordinary farm work and has sufficient speed for either wagon or carriage use. It is said to have a very quiet and tractable disposition.

Fig. 213. Hackney Mare Ladybird.
After Wallace.

609. *The German Coach horse* — The term German Coach may include also a special type of the German Coach horse known as the Oldenburg Coach horse. The origin of the breed is in many ways similar to that of the French Coach, the stallions from the Orient being crossed with the best common or native mares. There is evidence that the breed is a very old one. It is somewhat heavier than the French Coach, being about on an equality with the Cleveland Bay in respect to size. The most common colors are black, bay, brown, or chestnut. They have been imported to some extent in the United States but less extensively than the French Coach. They are suited to the same general uses as the Cleveland Bay.

610. *The Hackney horse* — This breed, which, according to Wallace, is also known in its native country by the name Norfolk Trotters, is of English

origin and was bred chiefly in Norfolk and Yorkshire. According to some authorities the ancestors of the Hackney on one side came from Norway, being brought to England by the Norse invaders, who had their strongholds in the two counties above named. On this Norse stock as a foundation stallions of the Thoroughbred and Oriental breeds have been repeatedly crossed, so that the origin of this breed is practically like that of the other heavy carriage breeds. The Hackney horse is somewhat shorter in the leg and more compact in figure than the French Coach, which breed, however, they approach closely in size. The colors found are chiefly bay, black, brown, and chestnut, often with a white star and sometimes with white feet and ankles. The Hackney horse is very high at the withers, shoulders very strongly slanted ; they carry the head high, and the neck is well arched; the back is short, the forearm is specially short, giving an unusually high knee action. The muscular development is usually powerful. In disposition these horses have the reputation of being kind. They have great style and it is claimed by some fair speed. According to others the exceedingly high knee action results in the Hackney putting its foot down in nearly the same place as that from which he took it. The Hackney is the favorite gentleman's driving horse in England ; and in the eastern cities of the United States, where so many follow English fashions, the Hackney is more popular than in any other part of the country. English fashion, and this in spite of the laws aiming to prevent it, is usually followed in this country and demands that the tail of the Hackney shall be docked.

XC — PONIES.

611. *Shetland ponies* — With increasing wealth, ponies are in increasing demand for children's driving and riding ; and among the various breeds of ponies none is so generally popular as the Shetland. The Shetland is the smallest of all ponies. Its native country is found in some of the islands of the west coast of Scotland, where it has become inured to extreme hardship, both as regards exposure to inclement weather and short food supply.

As a result of exposure for many generations to extremely hard conditions, the Shetland has become reduced in size until he is often not larger than a large Newfoundland dog. His legs are very short, body relatively very thick, muscular development fine, strength and endurance much greater than would be supposed possible in an animal of his size. Shetland ponies are, moreover, usually tractable and easily managed, so that they make safe animals for children to handle.

612. *Mustang and Indian ponies* — In our own country there are two breeds of ponies which deserve mention,— the Northern Indian pony and the Mustang. Both of these are descended from Spanish horses that escaped from the early settlers in Mexico. Both are much larger than the Shetlands, indeed the Mustang is almost large enough to pass for a horse. The usual height is from about 12 to 13 hands, the weight from 600 to 800 pounds.

The Northern Indian pony, according to some authorities, contains some of the blood of a small horse imported into Canada at an early date from France. This, however, cannot be considered as proved, and such differences as we find to exist between the Mustang and the Indian pony are fully accounted for by the greater severity of the climate to which the latter has been exposed. Both of these types of ponies were formerly wild in large numbers on the Western plains, from the southern boundary of the country northward into Canada. Both are characterized by great endurance. Mustangs have an unfortunate reputation for viciousness, but this they apparently do not deserve. Vicious habits are usually the result of faulty training. When handled intelligently the Mustang is not usually vicious. The Indian ponies are said to be kind and gentle as a rule, and both the Mustang and the Indian pony are very valuable as saddle animals for grown persons as well as for children.

613. *Welsh ponies* — Welsh ponies have been imported into the United States to a small extent and are bred by a few to satisfy the demand for children's use. The Welsh pony stands about 13 hands high and is much more slender and less chubby in form than the Shetland.

XCI — MULES.

614. Throughout the animal kingdom it is not as a rule possible successfully to breed together animals belonging to different species. This is possible in the case of the species to which the horse and the ass belong. These species may be paired in two ways : the male ass with the mare, or the stallion with the female ass. The offspring of only one of these crosses, however, is of much practical value, viz., the product from pairing the male ass with the mare. The animal produced by the opposite method of pairing, although in one sense a mule, is commonly known as a hinny, to distinguish it from the animal produced by pairing the jackass and the mare. There is a wide difference between the hinny and the mule. The former seems to inherit size from the ass and is too small to be of much value for work. It has the flowing mane and tail and approximate proportions of body, legs, and ears and the voice of the horse. The mule, on the other hand, takes size from the mare ; indeed, though the mare be paired with a jack smaller than herself, her offspring not infrequently exceeds her in size. The mule is proportioned more like the ass, and like the ass it brays instead of neighing. The breeding of mules requires special knowledge and experience. The mare must usually be blindfolded or secured in some way. Fecundation is less certain than between a

FIG. 214. JACK, ANTAR JR.
From Report Com. on Live Stock, Columbian Exposition.

male and female of either species. The duration of the period of gestation in mule breeding is longer than the normal period for the mare, averaging about 375 days. Abortion occurs somewhat frequently, and more care is necessary than in breeding either horses or asses. There are a number of distinct breeds of asses. The cut shows an animal of superior characteristics. The prevailing faults of the ass are: too large a head, too short a neck, sides too flat, shoulders low, croup narrow, arms and thighs thin, and hoofs very narrow. The mare should be chosen to remedy these defects as far as possible. The head, therefore, should be small, the body round, back short, chest wide, croup muscular, thighs and arms large, neck long and well set on, and hoofs wide and rounded. Mules, to a remarkable degree, inherit the shape and peculiarities of the sire, while from the mare they take size. It is said that they very rarely inherit bad form or unsoundness from the dam. It is common therefore, in districts where mule breeding is followed, to use for mule breeding mares which have become unsound, this being far safer than to use such mares for breeding their own species. The mule is an exceedingly valuable animal for work, especially in hot climates. Good mules are generally admitted to surpass horses in the following respects: —

1st. Longevity. They cannot be put to work at quite so early an age as horses,— usually not until they are from four and one-half to five years old,— but they are longer lived and can be worked a considerably greater number of years.

2d. Hardiness and toughness. The mule endures rough treatment and hardship much better on the average than the horse.

3d. Ability to subsist on rough food. The mule is far less dependent than the horse upon regular feeding with grain when at hard work.

4th. Hours of work. The mule will day after day and year after year endure more hours of work daily than can the horse.

5th. Ability to endure heat. The mule is far less liable than the horse to injury from sunstroke during the excessively hot weather with which all parts of our country are sometimes afflicted.

Intelligence and disposition. It is common to speak of the mule as an

animal almost invariably inclined to be vicious. The frequency of the jokes concerning his use of his heels is sufficient evidence of this. As a matter of fact, those accustomed to handling the mule claim for him that if properly handled he is not vicious; that indeed he surpasses the horse in average intelligence and will work kindly under almost all circumstances if kindly and intelligently handled.

The special use of the mule is without doubt for work, but good mules are very good drivers. With little doubt mules might profitably be more frequently employed than is the case. The average selling price of the mule is considerably higher than that of the horse, which is in itself evidence that his value as a working animal is appreciated where he is well known.

XCII — SHEEP (*Ovis aries*).

615. *The origin of domestic breeds of sheep* — The sheep was one of the first of animals to be domesticated by man, and the wild species from which it is descended is not certainly known. Numerous wild species are still in existence in different parts of the world, chiefly in mountainous regions and in dry climates. It is not known whether any of the now existing wild species is to be regarded as the parent stock, nor is it certainly known whether all domesticated breeds descended from the same wild species. The fact is, however, that, regardless of differences in size and in other characteristics, all known breeds breed together freely, and this is considered strong presumptive evidence of a common origin. Nearly all the breeds of sheep which are important in the United States have been brought into this country from Great Britain. The exception is the Merino, of which a number of types have been brought here from the countries of Europe, chiefly from Spain, Saxony or other parts of the German empire, and France.

616. *The breeds of sheep classified* — Various classifications of the different breeds of sheep are in use. Some divide all breeds into mountain and lowland breeds, others into hornless and horned breeds; others into fine, medium, and coarse wooled breeds. No classification is wholly satisfactory on account of the fact that there are no sharp dividing lines, — one

type merges into another by insensible gradations. We shall, however, include for the purposes of this book all the breeds, which will be spoken of under three classes: short-wooled, middle-wooled, and long-wooled breeds.

617. *General characteristics of sheep valued largely for mutton* — As most of the breeds of sheep which are of importance in the district in which it is expected this book will be chiefly used, are valued largely for mutton, it is thought best, for the sake of brevity in the descriptions of the different breeds, to try to give a clear idea of the general form shown with varying

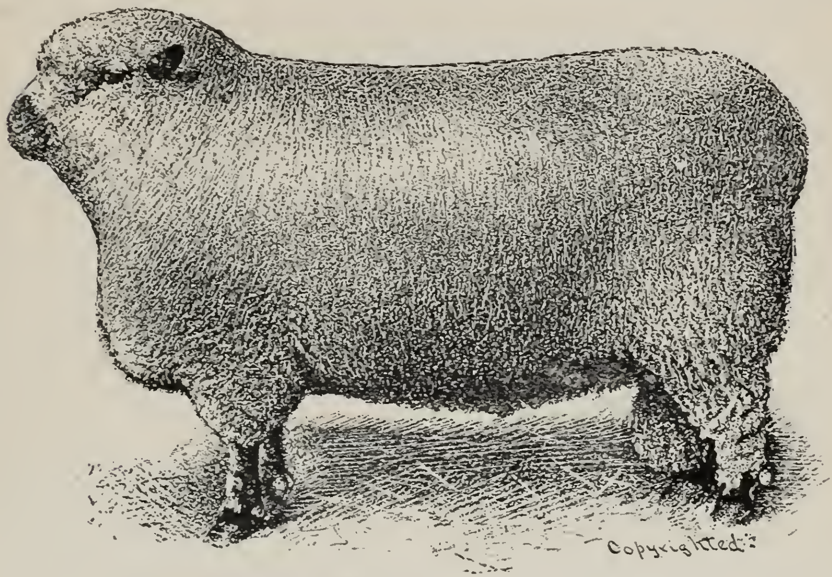


FIG. 215. SHROPSHIRE EWE, Fox's No. 3267, Marchioness 57710, awarded First Prize in class, also Sweepstakes, at World's Columbian Exposition.

By courtesy of Mortimer Levering.

degrees of perfection by the different breeds kept largely for mutton. As the names generally given to the different points in the external anatomy of the sheep are in general the same as those applied to the ox, or if different are readily understood, no cut showing the points is given. The reader is advised, in connection with the description of the mutton type which follows, to refer constantly to the cut of the Shropshire, which shows the peculiarities of the type in a very high degree of perfection. The ani-

mal which the cut represents took first prize and sweepstakes at the Columbian Exposition in Chicago in 1893. This statement of points is quoted with very slight modifications from Wallace.

"1. A *good carriage* and springy style of walking.

"2. *Neck* thick towards the trunk, tapering to the head, arching slightly, and not too short.

"3. *Body* deep, and projecting over the fore legs; under and upper lines straight.

"4. *Back* level and broad behind and before.

"5. *Ribs* well sprung and rounded.

"6. *Shoulders* well covered with firm flesh. The parts immediately behind the shoulders well filled up.

"7. *Thighs and also the fore flanks* well fleshed down.

"8. *Rump* well developed, though not too large, sometimes the case in Cotswolds, Border Leicesters, and other heavy-fleshed breeds.

"9. *Legs* straight, not too long nor the bone coarse. The hocks are much better slightly out than at all in or 'cow hocked.'

"10. *The body*, and particularly the belly, well covered with the characteristic wool of the special breed."

XCIII — SHORT–WOOLED SHEEP.

618. *Merino sheep* — The Merino is by far the most important among the short-wooled breeds. It has now come to be represented in the United States by a considerable number of types differing, the one from the other, to a considerable extent. In 1899 there were no less than sixteen different breeders' associations for Merino sheep, each maintaining its separate register. A number of the types among Merinos possess characteristics sufficiently distinct to entitle them to rank as distinct breeds, and, indeed, they are generally so regarded. All, however, possess certain characteristics in common and, since sheep of this type are of less importance in the Northeastern states than those which are of more value for mutton, the Merino will be considered as a whole and some of the more important subdivisions very briefly spoken of.

Touching the origin of Merino sheep Curtis says, "The Merino is certainly the oldest of surviving breeds and as its authentic history is almost co-existent with the history of Spain we may, for all practical purposes and without further question as to its remote origin, regard it as the creation of Spanish breeders, who used the finest sheep of Italy and Africa and were further assisted in improving their native flocks by the natural adaptation of Spanish soil and climate to the rearing of fine-wooled sheep."

Stewart says, "The Spanish Merino existed as a distinct race 2,000 years ago and the fine robes of the Roman Emperors were made from the wool of Spanish flocks."

The term fine wool as applied to Merino sheep is more descriptive than short wool, for the fleece of all the various types of Merinos is characterized by a degree of fineness which is not equaled by the wool of the sheep of any other breed ; and the Merino, whatever the type, may be regarded as preëminently a fine-wool specialist, though in some of the families the size has been so much increased and the form so greatly improved that the sheep have considerable value for mutton as well as for wool. The Merino in general ranks as a small to medium breed though a few of its families must be classed as large. The males are generally horned, and the females not infrequently have small horns. The face is white. In color the fleece of all Merinos appears dark — in some of the families almost black. The real color of the wool, however, is white or buff, the darker appearance being due to the hardening of the yolk or oil at the tips of the fibers and to the accumulated dust and dirt which it holds. The fleece in most Merinos is short or of but moderate length, but very fine and close. It shrinks more on being cleansed than the wool of most breeds, on account of the fact that in its natural condition it carries an unusually large proportion of yolk. The wool covers the body more evenly than in other breeds, maintaining its character round the head and face and on the legs where in other breeds the covering of these parts is hairy. The Merino makes a comparatively slow growth and is later in coming to maturity than the sheep of most breeds. It is hardy, and withstands exposure to severe weather and to storms better than sheep whose fleece carries less oil or yolk. It is also better suited to hot climates than are most breeds.

The Merino ewe produces but a single lamb at a birth and the ewes as a rule are not very good milkers.

The leading families of Merinos in the United States are the following: —

1st. *Atwood* — The skin of nearly the entire body is wrinkled or folded. The fleece is very short and fine, but the fiber is apt to be uneven in quality on account of the folds, which are looked upon with less favor than formerly. The size is moderate, usually ranging between about 100 and 130 pounds.

FIG. 216. RAMBOUILLET RAM.
By courtesy of Hon. F. P. Bennett.

2d. *Paular* — Paulars are moderately wrinkled but considerably larger than the Atwood, rams in full fleece sometimes reaching the weight of 200 pounds.

3d. *Dickinson* — Sheep of this family are smooth, large in size, ranging from about 150 to 200 pounds.

4th. *Blacktop* — The body is smooth, the wool at the tips is very much crusted and seems almost black, which gives the name. Sheep of this family are somewhat above the average Merino in size, ranging from about 125 to 175 pounds.

5th. *Delaine* — The body is smooth, the wool is somewhat longer than that of most Merinos and is adapted to combing rather than to carding and therefore to the production of a special class of fabrics. Sheep of this family are of fair size, good rams weighing about 150 pounds.

6th. *Rambouillet* — The Rambouillet was originally a French breed and is descended from sheep imported into France from Spain. The Rambouillet is the largest among the Merinos, the body is smooth, the wool somewhat longer than that of most Merinos and rather coarser. The Rambouillet is of considerable value for mutton as well as for wool.

Fig. 217. American Merino, Don Dudley.
By courtesy of John P. Ray.

The American Merinos in general are larger and smoother in the body than the Spanish sheep from which they descended. The wool is somewhat longer and probably averages a little coarser. This, however, is stoutly disputed by some. The Merino is the most valuable of breeds in the wool producing sections of the Southwest and West. It is also kept to a considerable extent in Northern New England and in New York. It is of comparatively little importance in the neighborhood of the large commercial and manufacturing centers of Southern New England and the Middle states.

619. *Horned Dorset* — The Horned Dorset is an English breed of medium size. The face is white; males have very long horns, females as a rule horns of moderate size. Nose, hoofs, and legs are white. There is a tuft of wool on the forehead. The great peculiarity of the breed is that the ewes will breed earlier than those of any other breed. They can, indeed, be bred at almost any season of the year, and they sometimes breed twice

FIG. 218. HORNED DORSET.
By courtesy of M. A. Cooper.

yearly. It was believed that this peculiarity in the breed would render it of especial value for the production of early lambs, which is the most profitable branch of sheep husbandry in many parts of New England and the Middle states. The white faced lamb, however, does not sell so readily as the darker faced; and Dorset lambs neither fatten as readily nor produce as delicate mutton as those of some other breeds. On this account the Southdown ram is frequently used on Dorset ewes, the cross-bred lamb fattening earlier and selling for a better price than the pure-bred. The pure-bred Dorset is characterized by rather light bone and a long body. The legs are relatively longer than in many breeds. The fleece is short and of about medium fineness. Dorset ewes are good mothers. The breed

is not as yet largely represented in the United States but it and its grades are worth attention where the production of early lambs is in view.

620. *Cheviot sheep* — The Cheviot takes its name from a range of hills on the Scotch and English border, its native district. It is a hardy breed, classed by English writers among mountain sheep. Face and legs are cov-

FIG. 219. CHEVIOT.
By courtesy of Robert L. Davidson, Cooperstown, N. Y.

ered with pure white hair which extends over the ears and well back behind the head. The rams are sometimes horned and horns are not objected to, being considered a mark of hardiness. The wool is moderately long and is adapted to the production of a special grade of cloth which takes its name from this breed. The size is medium. The breed, though not yet numerous, is increasing in popularity in the United States and may prove of value in the mountainous districts of the West.

XCIV — MIDDLE-WOOLED BREEDS.

621. *Southdown sheep* — This is an English breed which takes its name from the Southdowns, as the somewhat broken hilly lands of Sussex and the neighboring counties of England are called. This is the oldest of the Down breeds and is the most widely kept and the most generally known among

these breeds in the United States. The breed is hornless, the face and legs are of a gray brown color. The best rams when fat may reach the weight of from about 175 to 200 pounds, the ewes are about 50 pounds lighter. The fleece from a flock of ewes of good quality may average 6 or 7 pounds in weight. The wool is rather short and of medium fineness. In form the Southdown among sheep is about what the Devon is among cattle — of the mutton type but more rounded, and somewhat less square and heavy than some of the larger breeds. The flesh also compares with that of other breeds of sheep as does Devon beef with the beef of other breeds. It is looked upon as the standard of excellence. The ewes frequently produce more than one lamb at birth, two being common and three occasional. More than two is of course undesirable. The Southdown and its grades are among the most valuable of sheep for the production of early lambs.

Fig. 220. Southdown.
By courtesy of Chas. J. Stuckey, Mechanicsburg, O.

622. *Shropshire sheep** — The Shropshire breed of sheep takes its name from the county of England where it was brought to its highest perfection. It is a breed of more recent origin than the Southdown, being produced by crossing the native sheep, which were rather coarse, with Southdowns to effect a refinement in the type, and with the Leicester in order to maintain the size and mutton qualities. The breed has now, however, for many years been kept pure. In many respects it resembles the Southdown. The face and legs are blackish brown, the latter being somewhat the darker.

* See Fig. 215.

The face is frequently tinged with gray around the nose and eyes and about the jaw. The size is somewhat greater than that of the Southdown, rams commonly ranging between 175 and 225 pounds, ewes about 50 pounds lighter. The fleece is longer and somewhat more open and rather coarser than that of the Southdown. The average weight of the fleece is probably about 2 pounds greater. The breed is suited to much the same purposes as those mentioned in connection with the Southdown. It was introduced into the United States much later than the Southdown, but, perhaps chiefly

Fig. 221. Hampshire Ram.
By courtesy of Mrs. John I. Gordon.

on account of its larger size and heavier fleece, it has been received with great favor. They are quite largely kept in many parts of the country, but especially in the Mississippi valley. They are believed to be better fitted, as a result of the conditions under which the breed has been produced, for moist or even wet localities than most breeds of sheep.

623. *The Hampshire* — This breed takes its name from a county in

England. In this locality and in the adjacent regions north and west of it, it has been brought to its present form by crossing the old native sheep of the district with the Southdowns. Hampshires are larger and coarser than Shropshires and do not fatten so readily when young. The breed is hornless. The face and legs are almost black. The fleece is shorter and closer than that of the Shropshire and the average weight is not so heavy. Flocks of ewes are said to yield an average fleece of from about 4½ to 5 pounds. Mature rams weigh from about 200 to 225 pounds. Notwithstanding the fact that the lambs do not fatten as readily as do Southdowns, the Hampshire ram is generally regarded as one of the best for the production of early lambs. This is because the lambs grow with unusual rapidity. The Hampshire ram and grade Merino or Southdown ewes are often used by those engaged in the production of early lambs. The breed is not as largely kept in the United States as either the Southdown or the Shropshire. They are said to be more largely kept in the South, however, than either of those breeds, as they adapt themselves to the peculiar conditions better than do most breeds.

FIG. 222. OXFORD.
By courtesy of J. C. Williamson, Xenia, O.

624. *Oxfordshires or Oxfords* — This is the largest of the Down breeds. It takes its name from the county in England where it is said to have been formed by crossing Hampshire ewes with Cotswold rams. It is a hornless breed, with a dark face like the other Down breeds. The face is not so dark as is the Hampshire and the breed does not show as much uniformity as the other Down breeds, variation indicating the crossed origin. The fleece is longer and more

open and loose than that of the other Down breeds, the fleece of ewes averaging about 6 or 7 pounds. This is probably the least known in the United States of any of the Down breeds. The breed is said to be better adapted to life in a region where the pastures are wet and springy than any other breed of sheep.

XCV — LONG-WOOLED BREEDS.

625. *Leicester sheep* — The Leicester is an English breed comparatively little known in the United States. It is represented in England by at least two rather distinct types: the improved English Leicester, and the Border Leicester. Concerning the first of these Wallace says, "It is the smallest of the Leicester breeds and has been longer an improved breed than any long-wool except the Cotswold. Bakewell did this by in-breeding and selection."

FIG. 223. LEICESTER, ROYAL CHESTER 742.
By courtesy of H. A. Temple.

Concerning the Border Leicester Wallace says, "It was bred at first from Bakewell's Leicester, by crossing with the Cheviot, but now ranks as a pure breed and is one of the best of the Leicesters."

These two classes do not appear to be represented in the United States, there being but a single association of breeders of Leicester sheep. This association calls its flock register, "The American Leicester Record." These sheep are said to be better known in Canada than in the United States. Leicesters are among the large breeds, rams weighing in the

neighborhood of 200 pounds. The breed is hornless; the face and legs white; wool long, in good flocks from 6 to 10 inches; and the average fleece in such flocks is about 8 or 9 pounds. The Leicester among sheep occupies about the same position among the mutton breeds that the Shorthorn occupies among cattle, being splendidly adapted to production of cheap mutton of fairly good quality, when kept under conditions affording abundance of rich food.

626. *The Cotswold* — This breed is named from the Cotswold Hills in England. It is one of the oldest breeds and has very distinct characteristics. It has, however, in modern times been somewhat improved by the introduction of Leicester blood. It is now a large and hardy breed, well suited to feeding on heavy soils even when quite wet. The breed is hornless, the face and legs white. A large tuft of wool covers the forehead. The wool is long and rather coarse and the fleece is moderately open. Well-bred rams frequently weigh from 250 to 275 pounds. The breed is fairly well known in the United States and must be regarded as valuable both for mutton and for wool.

FIG. 224. TWO-SHEAR COTSWOLD RAM, with Two Months' Growth of Wool. First Prize at Vienna International in 1873. *After Wallace.*

627. *The Lincoln* — This breed takes its name from a county in England. There has been a breed of sheep known as Lincoln from very ancient times and this breed had a great reputation for length and quality of wool. In comparatively modern times it has been crossed with the English Leicester. This cross has resulted in improving the fattening qualities and mak-

ing the animal somewhat finer. It has, however, shortened the wool, lessened the quantity, and caused some deterioration in its quality and luster.

Fig. 225. Lincoln Ram, First as a Two-Shear Ram at the Royal Show at Preston in 1885, etc., etc.

After Wallace.

The breed is hornless, the face white; the wool is longer than that of any of the other long-wooled breeds, not infrequently from 9 to 12 inches. Flocks of the best type will give an annual clip of from 9 to 15 pounds to the fleece. The Lincoln is one of the largest of the breeds of sheep, mature rams weighing from 225 to 250 pounds. The Lincoln is comparatively little known in the United States. It is especially adapted to regions furnishing abundance of rich pasturage.

628. *The sheep, one of the most important of farm animals, but little kept in the New England states* — There are many advantages connected with sheep husbandry, not connected to an equal degree with the keeping of any other class of farm animals. It is possible by means of sheep to utilize rough and scanty pasturage to far greater extent than with either horses or cattle. The light and active sheep can win a subsistence where the herbage is so scanty that it would not afford support for the larger domestic animals. Moreover, as a result of pasturage with sheep, steady improvement is generally the rule, while deterioration is apt to follow pasturage with horses or cattle. The improvement following pasturage with sheep is in considerable measure due to the fact that sheep feed upon a much greater variety of plants than the other domestic animals. They are fond of browsing upon shrubs, weeds, and briars and help greatly in keeping down

growths of this character. Further, the droppings of sheep are distributed far more evenly in a pasture than is the case with those of either horses or cattle and therefore they help maintain the fertility of the soil to far greater extent. Sheep husbandry in the older states of the Union is now much less extensively carried on than formerly. The number of sheep has steadily decreased for many years. This is made sufficiently evident by the following table : —

NUMBER OF SHEEP IN THE UNITED STATES AND IN THE NEW ENGLAND STATES.

Year.	United States.	Mass.	Conn.	R. I.	Vt.	N. H.	Me.
1840	....	384,000	....	....	....	....	....
1850	21,723,220	188,651	174,181	44,296	1,014,122	384,756	451,577
1860	23,317,756	114,829	117,107	32,624	752,201	310,534	452,472
1870	28,477,951	....	83,884	23,938	580,347	248,760	434,666
1880	35,192,074	67,979	50,431	17,211	439,870	211,825	565,918
1890	35,935,364	51,438	37,652	11,400	333,947	31,611	370,484
1895	....	55,140	....	....	....	....	....

What has taken place in Massachusetts has taken place in considerable degree in all the older states. Massachusetts in 1840, as will be seen by reference to the table, contained 384,000 sheep. In 1890 it contained but 51,000. Since 1890 there appears to have been a slight gain, the number in 1895 being 55,000. In the United States as a whole, sheep husbandry has continued to increase since 1850, as shown by the decennial census reports. There was, however, quite a sharp decline soon after 1890, a decline which has since been in part recovered. Sheep husbandry is practiced in the United States as a whole, and especially in the older states, to a far less degree than in many other countries. Comparison with Great Britain shows an extraordinary difference. The total area of Great Britain is 88,000 square miles; that of New England about 64,000 square miles. In Great Britain the number of sheep in 1899 was rather over 27,000,000, while at the same time in New England the total number was only about 836,000. Great Britain has an average of 300 sheep per square

mile of total area. New England with the same average would have more than 18,000,000 sheep, and Massachusetts 2,340,000, whereas the actual number in Massachusetts in 1895 was 55,000. These facts make it abundantly evident that in New England sheep husbandry is greatly neglected. There must of course be natural causes. It is not my purpose exhaustively to discuss these causes, but two or three of the more important will be pointed out.

In the New England states we have to face formidable competition both in mutton and in wool. The West competes with us along both these lines, while, in spite of the duties on wool, foreign competition in that article is serious. As a result of this competition the prices are low.

In many parts of New England large numbers of dogs are kept and the killing and maiming of animals by these dogs operates in a marked degree to discourage the keeping of sheep. It is exceedingly disheartening to have gotten together a fine flock of sheep only to have the flock, in a night perhaps, destroyed. True, our laws have been so drawn that the owner recovers the value of sheep killed, but the money gained is no offset to the pain which the good farmer feels when he finds choice animals in which he has taken a pride, and for which he has an affection, maimed and torn by dogs. Such a method of marketing is unsatisfactory from every point of view. Even the animals in a flock not directly injured by dogs are rendered so wild and nervous that they fail to thrive; and the usual consequence of a few incursions by dogs is that the farmer decides to give up sheep keeping. There can be little doubt that this branch of agriculture would show a marked increase but for the discouragement incident to the injuries from this source. Such legislation as has been adopted with a view to preventing injuries from dogs, although it furnishes money to pay the damages inflicted in this fast dwindling branch of husbandry, does not operate to prevent to any great extent the multiplication of dogs in our midst. The writer is a lover of dogs, but he recognizes that the public—that the sheep farmer especially—has certain rights which keepers of dogs should respect; and he believes that the European system, requiring all dogs when off the premises of their owners to be muzzled, is only reasonable.

There are of course certain cities and towns in the state where no sheep are or can be kept, and here it might be unnecessary to enforce a law requiring muzzling. The suggestion that counties or townships be allowed to vote on the question as to whether dogs shall be muzzled or not, as towns and cities now vote on the question of license, appears to be wise and reasonable. The dog, however, has so many friends in the thickly settled older states — the farmer is in such a minority — that the adoption of such legislation as has been hinted at is doubtful. It remains to inquire whether sheep husbandry in a dog-infested neighborhood can be safely followed. The modern wire fence, without doubt, answers this question. It is possible to fence in such a manner as to keep out dogs, and that too without a degree of expense which is prohibitory. Many farmers without doubt hesitate to fence against dogs, and possibly in many localities it might not under present conditions pay to do it ; but, in sections where the production of early lambs is desired (which as has been stated, 619, is the most profitable branch of sheep husbandry in many parts of the older states), it would without doubt pay to make the somewhat large expenditure necessary to put up dog-proof fences. Though the cost of such fences is high, the wire is exceedingly durable. There are many kinds of wire fences which may be used, but among them all the Page wire fence is without doubt one of the best.

XCVI — SWINE.

629. *Origin of domestic breeds of swine* — The hog was very early domesticated. Domestic breeds contain the blood of two species : *Sus scrofa* and *Sus indicus*. *Sus scrofa* is the wild species of Europe and some domestic breeds contain the blood of this species only. *Sus indicus* is of oriental origin and the Chinese breeds of swine contain only the blood of this species. Very many of the modern breeds of hogs contain the blood of both. The domestic breeds that sprang from the wild hog of Europe resemble that type in a number of important particulars. The body is longer, leaner, and narrower than in the Chinese hog. The animal is coarser in bone, is coarser indeed in every respect, than the Chinese. The nose is longer, the forehead narrower, the constitution is hardier and the hogs of this type

are in general more prolific. The breeds found in the United States are some of them direct importations from Europe, more or less modified under the influence of American breeders and American conditions. A number of breeds, however, have taken their origin in the United States. These have been produced mainly by judicious combinations of blood of breeds originally imported from England, though occasional importations from other countries have been made, and the blood of these breeds also has in some cases been used in fixing the type of the American breeds. Such breeds, whether English or American, as have been formed by combinations of the blood of the Chinese with the coarser breeds, more or less directly descended from the wild boar of Europe, are in general much improved in a number of important particulars, chief among which are greater fineness of head, bone, and all important features, and increased tendency to take on fat.

630. *The breeds of hogs classified* — The classification of breeds which is here adopted is the division into three groups : large, middle, and small breeds. This classification is to a certain extent arbitrary because here, as practically everywhere in nature, there are no sharp dividing lines, one type passing into the other by insensible gradations. Some writers classify according to color, making three groups,— white, reddish, and black, — but this classification is objectionable for the reason that it separates breeds which are valuable for essentially the same purposes. Under many circumstances the color does not affect the value of the animal, but where the carcass is to be sent to market for sale as fresh meat the white hog is in general somewhat preferred to an animal of any other color. True, if the colored hog is very carefully dressed, the dead carcass may present as attractive an appearance as that of the white hog ; but without great care the dressed carcass of the colored hog will show spots of the dark colored hairs and this may lessen its salability. Where the hog is to be pastured a considerable share of the time, animals of the colored breeds are generally preferred as they bear exposure to hot sun better than the white breeds.

631. *The points of the animal named* — While the names applied to the external parts of the hog are in general similar to those which are used for cattle, there are certain small differences which must be pointed out.

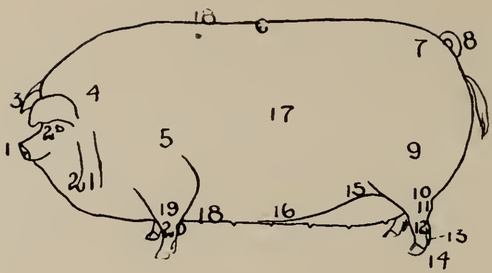


FIG. 226. HOG, SHOWING POINTS.

1.	Nose or snout.	8.	Tail.	15.	Flank.
2.	Face or dish.	9.	Ham.	16.	Belly.
3.	Ears.	10.	Lower thigh.	17.	Side or ribs.
4.	Neck.	11.	Hock.	18, 18.	Girth.
5.	Shoulders.	12.	Shank.	19.	Forearm.
6.	Back.	13.	Dew claws.	20.	Knee.
7.	Rump.	14.	Hoof or foot.	21.	Cheek or jowl.

632. *Points in general applicable to all breeds* — As the general form and shape of the different parts looked for in a hog are with minor exceptions similar in all breeds, it is best for the sake of brevity to give a description of what may be considered the ideal type. This description is taken with slight modifications from Wallace.

"*Feet* — small, upright, neat.

"*Legs* — Straight, fine-boned, fleshed down as far as possible in both fore and hind quarters.

"*Back* — Broad before and behind, not drooping too much at rump. Pigs are all liable to arch the back and droop in the rump when standing. Back line straight and extending over the neck ; belly line parallel and continued below the jowl.

"*Ribs* — Well sprung and deep.

"*Neck* — Thick and of medium length.

"*Ears* — In most, not too large nor drooping.

"*Head* — Small, short between eyes ; nose short and under jaw shorter than upper ; cheeks very full ; eye not too small, mild but bright and quick.

"*Tail* — Long with tuft of long hair at tip.

"*Body* — Well covered all over with flesh, and of a rectangular outline from all points ; deep and wide before and behind.

"*Skin* — Medium in thickness and covered with an abundance of hair."

An animal having the points above outlined would still, as a rule, be likely to be looked upon as approaching more nearly to perfection than any other ; and yet it is important to point out that, within the past few years, the markets call for a hog of a somewhat different type from that which was earlier approved. Consumers demand a larger proportion of lean meat and less fat. Bacon and ham are more valuable than fat pork, and in proportion as the tastes of consumers are met, the consumption of hog products tends to increase. A hog long in body, with good depth at the ribs, light in the neck and fore quarters, and deep behind, will furnish relatively more bacon and ham (the parts which bring the highest prices) and a smaller proportion of shoulder, cheek, etc. (the parts which bring a relatively low price). Such a hog is likely to have a somewhat longer nose than is usually popular at the present time in the show ring, where the old ideas as to the best form for a hog are still too generally held.

XCVII — LARGE BREEDS OF HOGS.

633. *The Berkshire* — The Berkshire is an English breed, taking its name from its native county. The breed is said to have been produced by crossing an old English stock with the Chinese hog. The color is black with some white in the face and white feet and a white spot at the tip of the tail. White spots occasionally appear elsewhere but they are considered undesirable. The face is short, considerably dished, ears erect, the body long, the proportion of

FIG. 227. BERKSHIRE BOAR, KING LEE.
From Report Com. on Live Stock, Columbian Exposition.

lean meat is relatively large, thus rendering the breed well adapted for the production of bacon. The bone is fine. This breed was early introduced into the United States and is considerably kept in most sections. In the great stock-producing sections of the West, where hogs usually follow steers, the Berkshire is regarded as too fine-boned, being more liable to accident than the hogs of some other breeds. The animals of this breed are remarkable for activity and will do better at pasture than those of many other breeds. The Berkshire does not reach as large a size as most of the breeds in the class in which it is included.

634. *Poland China* — This breed is of American origin and Ohio is its native state. The breed is supposed to have been formed by combining with the blood of the common hogs of the district (which are supposed to have been descended from Poland stock brought in by German immigrants) the blood of a number of other breeds, among which were the Big Chinas (large white hogs with sandy spots), Irish Graziers, and Byfields (which are said to resemble the Chinas in form).

FIG. 228. POLAND CHINA BOAR.
By courtesy of Jas. Baynes & Son.

It first became known as a breed under a number of different names about 1835 to 1840. The name Poland China was officially adopted in 1872. In the great stock-producing sections of the United States this is by far the most popular breed, and there are at the present time no less than six breeders' associations for Poland China hogs, each maintaining a separate herd book. In color the Poland China is black and white in distinct patches, the proportions of the two colors varying. The nose is of medium length, face somewhat dished, ears drooping. In size it is about 100 pounds heavier than the Berkshire, mature hogs easily being made to reach weights of from 600 to 750 pounds. They have strong, firm bones and are less liable to accident when placed with fattening steers than Berkshires. They are also said to be more quiet in disposition and to fatten somewhat more readily.

635. *Duroc Jersey* — This is a breed of American origin; but the source of the blood which it contains is not certainly known. It is believed by many to be descended from the original Berkshire, which many years ago often resembled, in color at least, the present Duroc Jersey. Indeed, Wallace, in his book on British live stock published not many years ago, says that the Berkshires of England are still not infrequently of a dark brown color, and that they are descended from the chestnut colored native pig. The Duroc Jersey varies in color from a yellow to a shade of red with occasional markings or spots of black. The ear is large and pendulous, nose of moderate length, head short, body long, hair thick and coarse, legs long, and bone rather coarse. The breed is hardy and prolific. It is considerably kept in the South, but in the country as a whole it is much less important than either the Berkshire or the Poland China. There are two breeders' associations, each maintaining a separate herd book, in the United States.

FIG. 229. DUROC JERSEY.
By courtesy of Robert J. Evans.

636. *Tamworth* — This is an English breed comparatively recently introduced into the United States and Canada. It is said to partake more of the characteristics of the original wild boar than any other breed of swine. The gradually growing popularity of the breed in recent years appears to be due to the fact that in many respects it better satisfies the modern taste, which, as pointed out (632), demands a larger proportion of lean meat than in earlier times. In color the Tamworth is red of varying shades, sometimes as deep as mahogany. The nose and head are long, the ears erect, the body and legs long, the ribs deep and flat. The fore quarters are proportionally less broad than in many of the other breeds, but the

hams are large. The Tamworth is so different from the type of hog to which our farmers have been accustomed that they are not inclined to receive the breed with favor. Its popularity has grown more rapidly among the Canadians than in the United States. The breed appears to be hardy and fairly prolific, but is not yet of much importance in the United States.

637. *The Large Yorkshire* — This breed, usually spoken of in its native country as Large White, is of English origin and it is claimed that it is descended directlv from the original stock of the country without crossing with foreign blood. It is the largest of the English breeds. It has been vastly improved within recent years but still posesses many of the points of the wild pig, viz.: hardy constitution, more or less drooping hind quarters, large head, long nose, large and hanging ears, strong bone, flattish sides and proportional narrowness, as compared with the Berkshire when the great length and weight of the animal are taken into account. The Yorkshire is a white breed. It is not very much kept in the United States, its place being taken by the Chester White, the blood of which was doubtless in large part derived from the Yorkshire.

FIG. 230. TAMWORTH BOAR.
After Wallace.

638. *Chester White* — This breed originated in Chester county, Pennsylvania, and must be looked upon simply as an improvement upon the Large Yorkshire, which breed it still resembles in many important particulars. Chester Whites are large, hardy, breed well, and make good mothers. They are somewhat finer in bone and thicker in body than the Large Yorkshire. The color is indicated by the name. The ear is pendulous. Chester Whites can probably be made to reach a larger weight than hogs of any other breed. They easily gain an average of one pound a day up to the

age of two years and there is authentic record of the following live weights: for a boar, 1,307 pounds, sow, 1,253 pounds. Hogs of this breed are not infrequently grown to a dressed weight of 1,000 pounds or more. Though capable of growth to such enormous size, the Chester White is easily fitted

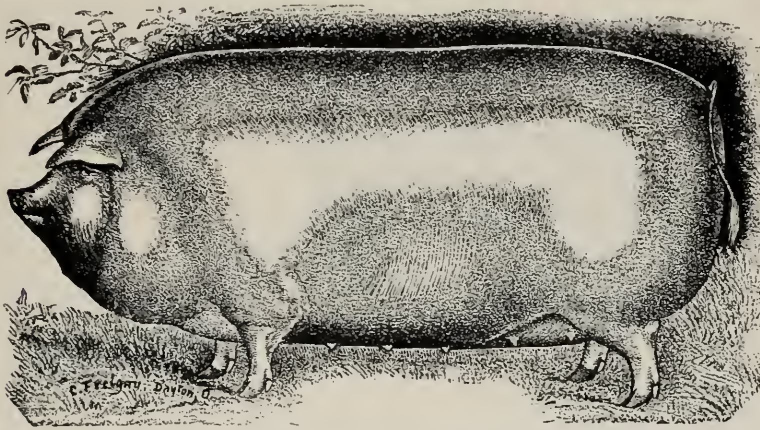


Fig. 231. Chester White.
By courtesy of Carl Freigau.

for slaughter at almost any age. It is one of the best known and most popular breeds of swine in those parts of the country where these animals are generally kept in confinement. It is not as well fitted for grazing as some of the other breeds. There are four breeders' associations, each maintaining a separate herd book, in the United States.

XCVIII — MIDDLE BREEDS.

639. *The Middle Yorkshire* — This breed, often known simply as Middle White in England, has undoubtedly been derived in that country from the Large Yorkshire. It has been decreased in size, and refined in bone by selection and the introduction of Chinese crosses. The Middle Yorkshire is not generally kept under that name in the United States, but the Cheshire and Suffolk are of substantially the same type, and these will be somewhat fully described.

640. *Victoria* — According to Curtis there are two distinct breeds,

each known under the name Victoria. Both are of American origin; one having been improved mainly by Colonel F. D. Curtis in the state of New York, the other by a Mr. Davis in Indiana. According to the same authority the two are distinct and he proposes that one be known as the Curtis Victoria and the other as the Davis Victoria. Up to the present time, however, there is but one breeders' association and but one herd book. Of that the Mr. Davis of Indiana, above named, is the present secretary. This breed alone will be described. It is said to have been produced by blending four different breeds,—Poland China, Chester White, Berkshire, and American Suffolk. The head is small, face dished, but the nose not upturned as much as in the Small Yorkshire, the ears erect or slightly drooping. The breed would appear in most important particulars much like the English Middle White or the Cheshire, though relatively somewhat shorter and thicker in the body than the latter. As the breed is comparatively new it is not yet either generally known or widely kept.

FIG. 232. MIDDLE YORKSHIRE.
After Wallace.

641. *Cheshire*—This breed was undoubtedly derived from the White Yorkshire of England. It has been extensively bred in Jefferson county, New York, and from that center has been gradually disseminated into a number of other states. The breed is comparatively new and is said to be somewhat less uniform than many others. The color is white, the head is small but moderately long, the ear erect, hair thin, legs rather long, body unusually long in proportion to the other dimensions, bone fine. The breed is as yet much less important than many others, but undoubtedly possesses characteristics which when well fixed should render it a favorite where hogs are kept in confinement.

XCIX — SMALL BREEDS.

642. *Small Yorkshire* — This breed, known in England as the Small White, is with little doubt the most generally useful and most widely kept among the various breeds of swine, where these animals are kept in close confinement and forced from the start in order to fit them for slaughter at a comparatively early age. The nose is exceedingly short and as the animal grows turns upward until it finally resembles in shape that of a pug dog. The lower jaws are dished, ears erect, and cheeks very heavy. When the animal is fat the eyes are almost invisible, the neck is moderately long and well covered with flesh, making the head appear lower than the shoulders. The latter are wide apart, the whole body very thick in proportion to the length and height, the hind quarters long and square, flesh well down to the hocks, legs short and well apart, hair soft and silky. The Small Yorkshire can be readily fattened at any age and yields most profit when slaughtered on reaching a live weight of from about 175 to 200 pounds.

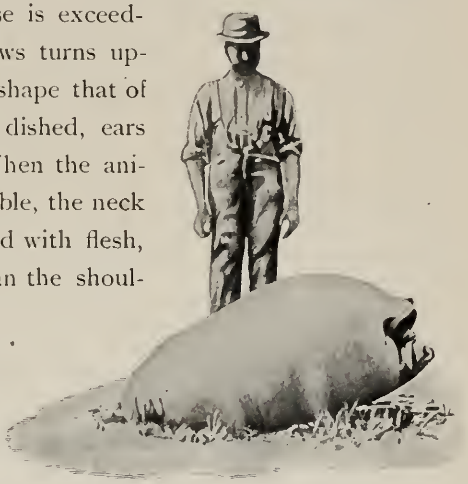


FIG. 233. SMALL YORKSHIRE SOW.
After Wallace.

643. *Essex* — The Essex is an English breed, formerly described as a parti-colored animal ; large and coarse in bone. The breed was refined by the introduction of the blood of the Neapolitan swine. The breed in about its present type has been recognized as distinct for something more than fifty years. The color is black, face short and dished, ears small, standing erect while young but drooping slightly with increasing age, hair ordinarily very thin, carcass long, broad, and deep. The animal fattens readily. The breed has never become generally popular in the United States.

644. *American or White Suffolk* — The American Suffolk is undoubtedly only a variety of the Yorkshire and appears to be practically identical

with swine generally known in England as Middle White. The head is small and very short, face dished, ears short and upright. Further description appears uncalled for. The breed is not yet extensively kept in this country. It would seem to be suited to about the same conditions as those mentioned in connection with the Small Yorkshire (642).

645. *Neapolitan* — Animals of this breed were imported into this country from Italy. It is believed that they were originally of Chinese blood. The first importation into the United States of which there is a record was made about 1840. Hogs of this breed are of a slate or bluish plum color, with a cast of coppery red. The size is small, the bones and joints are smaller and finer than in any other breed. The hind quarters are more largely developed than the fore quarters. Animals of this breed have played an important part in refining and improving some of the American breeds. As a pure stock the Neapolitan swine have never been largely kept, and whether they are found at all in this country at the present time the writer is uncertain. They are not represented by an association of breeders and there is no herd book.

646. *Chinese swine* — This breed is very briefly described because of the part it has played in the improvement and refinement of so many of the American breeds. There is considerable variation among the swine of China and the neighboring countries, but in many important respects they resemble each other. "They are distinguished," says Sanders, "by their small size, round bodies, somewhat hollow in the back, with belly trailing near the ground, in consequence of the extreme shortness of their legs. They vary in color from pure black to pure white, with various mixtures of the two colors. The bone is fine and they fatten very rapidly on a small quantity of food, maturing at a very early age. They are less hardy and prolific than the English breeds." This breed is not known to be at present represented in the United States.

C — THE HOG ON THE FARM.

647. *The hog produces cheap meat* — The fact that a pound of meat can be produced more cheaply through the keeping and feeding of hogs

than through the keeping and feeding of any other animal is generally well known. Some of the more important reasons why this is the case are the following: —

1st. For a certain amount of food consumed the hog makes a larger gain in weight than the ox or the sheep.

2d. The form of the hog is such that there is less waste than with other domestic animals. The body is compact, solid; the legs short and small; the proportion of offal is, therefore, much less than in the ox or the sheep. The well-fatted ox shrinks from about 35 to 40 per cent. on dressing, the well-fatted hog less than 20 per cent.

3d. The hog is the most prolific of the ordinary domestic animals kept for meat production.

4th. Hogs consume many kinds of food which could not well be otherwise disposed of. It is the most omnivorous of our domestic animals.

648. *The kind of hog to keep* — From what has been said concerning the different breeds, the farmer will be able to decide, in case he concludes to keep pure-bred stock, which will best suit his conditions. It may be doubted, however, whether it will be best for the farmer to select a pure breed for general purposes. Should he propose to make the production of stock for sale for breeding purposes a specialty, he will want a pure breed; but if his object is simply the production of stock well suited to the making of cheap pork, it will not be best under ordinary circumstances to keep pure-bred stock. It is usually advisable, if the farmer breeds his own pigs, to select for mothers grade sows which are of good size, long, rangy, and not over refined. Such sows will have good constitutions, bring large litters of pigs, and make good mothers. It will be best to breed these sows to boars of one of the smaller refined breeds which fatten easily at any age. For the Northeastern states it is believed that white animals should be selected where the practice is to feed almost wholly in confinement. If it is proposed to pasture the animals largely, then dark colored animals may be preferred. A cross between a Small Yorkshire boar and a grade sow, such as has been described, will generally suit the conditions existing in the Northeastern states. Grade Chester White sows may be counted upon to make good mothers for that section.

CI — GENERAL PRINCIPLES OF STOCK BREEDING.

649. *Possibilities and interest* — The extent to which the characteristics of animals can be changed by the intelligent breeder is enormous, as is sufficiently evident from the wide differences which exist between the different breeds of the same species. Within certain limits the animal in the hands of the breeder is like clay in the hands of the artist. It can be moulded at will, and he who has intelligently practiced the art of stock breeding has found it of deepest interest. Stock breeding has been spoken of as an art. It is both an art and a science. As an art it has been practiced from the earliest times. It has been long known that the characteristics of parents are as a rule transmitted to their offspring. "Like begets like" and "Breed from the best" are maxims which were acted upon long before the scientific principles which underlie breeding were understood. In the early efforts at stock breeding there was often a lack of system and hence results were comparatively small. Robert Bakewell was one of the first to demonstrate the enormous possibilities of the breeders' art. Bakewell lived during the latter part of the eighteenth century and effected enormous improvement in Leicester sheep, Longhorn cattle, and Shire horses. He carefully studied the form and proportions of animals and their relations to desirable qualities ; and having arrived at clear ideas upon these points he was able to place before his mind an ideal model of perfection. He then worked persistently, carefully, and methodically in the effort to realize his ideal in the living animal. Herein lay the secret of his success. Every successful breeder must first form distinct ideas as to the results which he wishes to produce and then work carefully and persistently towards their realization.

650. *General characteristics of all good animals* — The relative value of animals depends upon their adaptation to a particular purpose and to the return they make for food consumed. The animal that returns the greatest quantity of any desirable product for a given amount of food is the most valuable. It makes no difference what the product may be ; whether flesh, fat, milk, wool, or work, the rule is the same. The food which animals eat must be used in part to carry on the vital functions, to make good the wear

and tear incident to life. Only what the animal can eat and assimilate in excess of this portion can be converted into useful products. It therefore follows that the animal which eats, digests, and assimilates most in proportion to live weight is most profitable, for the amount used in carrying on the vital functions remains practically the same whether the animal eats much or little.

651. *Objects of breeding* — Every intelligent breeder should have for his object the improvement of his animals in those qualities which have a definite value, among which production of meat, wool, or milk, and the capacity for labor are the most important. Most successful breeders have sought to improve their animals only in one of these qualities, the others being neglected. Success is much more certain when the effort is thus concentrated upon some one point. It may be possible to improve a breed of cattle, for example, both in beef and dairy qualities at the same time, but this is more difficult than to improve them in only one of these directions. The different qualities for which animals are valued may not be absolutely incompatible one with the other. A fairly high degree of excellence in more than one direction may be obtained, but the very highest possible degree of excellence in one direction can be obtained only when other qualities are in large measure sacrificed. The modern art of breeding is founded on the practice of successful breeders and its rules are for the most part the result of experience. Science has furnished the explanation for these rules and made it possible to apply them more intelligently ; but the art of breeding has kept in advance of the science.

CII — HEREDITY.

652. *Heredity defined* — Heredity may be defined as the transmission of physical or mental peculiarities and qualities from parent to offspring. The subject must be considered under three heads : First, heredity of normal characters ; second, heredity of acquired and abnormal characters ; and, third, heredity of diseases.

653. *Heredity of normal characters* — That offspring inherit the characteristics of their parents is a generally accepted law of the animal organiza-

tion. The resemblance is not external only, but extends to the internal structure and to the functional activities. The peculiarities of the nervous system and of the mind; the development and strength of the organs of nutrition and reproduction; habits, disposition, and temperament; the form and strength of the bones and muscles, and the power of endurance,—all may be inherited. There are, of course, cases where the offspring do not seem to resemble parents, but sooner or later it generally appears that the exception is only apparent; that, though of course there may be minor differences, in most important respects offspring are like their parents. The extent to which mature individuals transmit characteristics, however, varies. If an individual stamps its likeness to a remarkable degree upon its offspring, it is said to be prepotent. Some families, as well as some individuals, are remarkable for their prepotency, *i. e.*, their offspring resemble them very closely. Justin Morgan (596) is an example of an individual horse which was remarkably prepotent. The whole Morgan family descended from him was prepotent in unusual degree. Imported Messenger also was prepotent to an astonishing degree. It has been said that he must be regarded as having been worth $100,000,000 to the United States—so great was the improvement due to him and his descendants.

654. *Heredity of acquired and abnormal characteristics.*—Habits which animals acquire as a result of the conditions under which they are kept, or even those acquired as the result of training at the hands of man, are likely to be transmitted to offspring. Thus, for example, the Shorthorn, under the influence of the conditions under which the animal has been bred and fed, comes to maturity at a much earlier age than animals of the wild stock. He also has much greater tendency to lay on fat. These characteristics are transmitted to offspring with much certainty. The Jersey cow has been made to produce milk far richer in butter than was normal to the species. This characteristic is now surely transmitted. The American Trotting horse has been bred and taught until even when pressed to the highest speed he still maintains the trotting gait, whereas all horses in a state of nature, when desirous of going fast, run. Other examples without number might be given but it is unnecessary. Those which have been mentioned

are sufficient to establish the general fact that acquired characteristics and habits are likely to be transmitted. If, however, an acquired habit is too much at variance with the natural instinct of the animal, it is much less likely to be transmitted. Pigs, for instance, are said to have been taught to spell and to point game, but there is no record that the offspring of such pigs showed precocity in these directions. Among abnormal characteristics which are transmitted may be mentioned an extra number of toes. This is illustrated by some breeds of fowls and among cats. The hornless condition of cattle may be mentioned as another example.

655. *Heredity of diseases* — There has been much discussion as to whether diseases are transmitted from parent to offspring. It seems to be well established that when the disease is of such character as to cause a marked change in the structure of any part of the animal it is likely to be hereditary, but when the disease consists simply in disarrangement of some function or when it is due to the presence of germs of some sort it is not hereditary. The hardy animal, however, the animal with all its organs, its skeleton and its muscles well developed, usually has great capacity to resist disease and is the safest animal to breed from. If an animal is affected with disease, there exists strong possibility that the part affected may have been naturally weak, and offspring, although they may not inherit the disease, are likely to inherit weakness of the part which is diseased in the parent, and, being weak in that part, they are likely in course of time to become diseased in the same part. Thus, for example, bone spavin or ringbone in the mare or stallion may not be directly transmitted to the foal, but the probability is that the joint in the parent affected by either of these diseases was weak, and weakness in this joint will be transmitted ; and the foal under hard usage will be likely to contract spavin or ringbone. If but one of the parents is affected by disease, the probability that the offspring will inherit it is much less than in case both parents are affected by the same disease. Should the latter be the case, the disease, or the tendency to it, is very sure to be transmitted.

656. *Atavism* — Any peculiarity of an ancestor more or less remote, whether of form, color, habits, mental traits, or predisposition to disease,

may make its appearance in offspring without having been observed in the parents. Such reversion to an ancestral type is called atavism. A tendency to atavism has been observed among all animals and the breeder must not be discouraged if it now and then appears. Good examples of atavism have been observed in the case of some of the hornless breeds of cattle. Again and again individuals developing horns have been produced even when for a number of generations all the ancestors have been hornless. In such a case it is only necessary to reject for breeding purposes such individuals. With lapse of time such tendency to reversion or atavism tends to decrease.

657. *Law of correlation* — Any peculiarity in the development of an organ or set of organs is usually accompanied by a modification of organs belonging to some other part of the system. In a great majority of cases the extraordinary development of one organ is accompanied by a corresponding deficiency of development in another. In the human being, as the brain and the parts which protect it become developed, the face becomes smaller. In the bat, the fore legs developing into wings are extraordinarily developed, the hind legs have become very small. In the kangaroo the enormous development of the hind legs is accompanied by a decrease in the size of the forward legs. In a blind person the sense of touch is remarkably developed. A horse with a white blaze in the face almost invariably has white feet. Fashion has decreed that in the case of the Sebright bantam the tail of the cock shall be like that of the hen ; the male in this breed is often sterile. The nose of the hog of many breeds, as the animal's tendency to lay on fat has been increased, has been shortened. Of late years hogs producing a larger proportion of lean are called for. The Tamworth perhaps produces a larger proportion of lean than any other breed. This breed is characterized by a very long nose. Many breeders, influenced by habit, will try to shorten the nose. It is to be expected that at the same time the tendency to lay on fat will be increased. These examples will have made clear what is meant by the law of correlation. The practical deduction is that it is impossible to modify one part as the result of breeding without at the same time producing other modifications which may be undesirable.

The breeder must be on the watch for such undesirable changes and when they manifest themselves must take steps to avoid them.

CIII — VARIATION.

658. *Variation is as universal as heredity* — Domestic animals like other species, both of animals and plants, possess the ability to a remarkable degree to adapt themselves to the conditions in which they are placed, and whenever the conditions are changed the offspring from generation to generation tend to vary in such direction as to become better and better fitted to the conditions of the changed environment. Improvement in form and valuable qualities will follow favorable changes in conditions ; but deterioration and loss of valuable qualities will follow when the conditions become unfavorable. Domestic species vary more than wild species. The distinguishing characteristics of the various breeds have been produced mainly by the modifying influences which prevail in the locality in which they have originated.

659. *Variations due to climate and food* — A warm climate with a liberal supply of nutritious food produces a large growth. A cold climate, a scanty supply of food, decreases the size. Bantams among fowls, ponies among horses, have been produced as the result of exposure to severe climate with a scanty food supply, while the large draft horses of Europe have been produced in a mild climate in a region producing an abundant supply of food. It is well known that, if two branches of a breed be widely separated and left to themselves, marked differences, in time, will appear, these differences being a result of the tendency of animal life to adapt itself to the conditions in which it finds itself. If the conditions change too greatly, a race may die out, but if the change is not too great a few individuals will live and their offspring will differ materially from their parents in the direction of being better adapted to the changed conditions. Man may to a certain extent modify or prevent the influence of climate. He does this mainly by providing shelter and food. Thus, for example, left to themselves in Canada horses would undoubtedly gradually decrease in size until a race of ponies would result. Man provides warm shelter in inclement weather,

gives abundance of food, and the size is maintained. Most of our modern breeds have been produced largely as the result of the influence of artificial conditions and if the same conditions can be maintained the character of the breed may remain unchanged, but it is a great mistake to suppose that the characteristics of any of our highly improved breeds of live stock can be retained in the absence of the conditions which produced them. If high feeding has developed the characteristics of an animal in a certain direction, a scanty food supply will result in a loss of these characteristics or may even cause the animal to vary in the opposite direction. In order to retain the improved characteristics of any breed, the system of management under which these characteristics were developed must be continued. All improvements in breeds of live stock have been slowly produced by skillful breeders under the best conditions. They may be quickly lost by failure to continue these conditions. The dairy cow has been developed until she gives an enormous quantity of milk. Let her be turned wild, and her descendants will soon lose this capacity. The Shorthorn and Hereford have been developed to mature early, to fatten readily. Turn animals of these breeds wild on the plains of Texas and their descendants will soon be profoundly modified.

660. *Sports* — A sudden or spontaneous variation from the normal type, which appears to occur without any cause which can be detected, is said to be a sport. Both animals and plants occasionally produce sports. New characteristics produced as a result of a sport are not usually transmitted with certainty at first, but there is great probability that among the offspring of an animal which is the result of a sport, some will develop the same peculiarity. In such cases by breeding together parent and offspring, both exhibiting the same peculiarity, it will usually be found possible to fix that peculiarity and thus to originate a new breed. It may be that at first a considerable proportion of the offspring will fail to show the new characteristic ; but if such individuals are rejected for breeding purposes and the breeder persists in his effort to fix the new characteristic by breeding only from those which show it in the highest degree, the characteristic will gradually become more and more fixed, until in course of time variations from it will seldom occur, and may at last entirely disappear. In this way

a new breed may be formed. There are many examples among domestic animals and fowls of breeds originated in this way. Tailless fowls, hornless cattle, and many of the breeds of pigeons are examples.

CIV — FECUNDITY.

661. The fertility of animals is frequently influenced by conditions which are not in themselves unfavorable to health. Thus wild animals when placed in confinement often fail to breed, although they may be perfectly healthy. When, however, animals have become fully domesticated, they often exhibit greater fecundity than the corresponding wild species. Thus, for example, tame geese and ducks lay more eggs than wild ; the dog produces more young than the fox or wolf ; the domestic hog, tame rabbits, and pigeons, more than the wild. In such cases the increased fruitfulness is undoubtedly due to the more abundant and sufficient food supply and to the more uniform conditions under which the animals are kept. The activity of the reproductive organs depends upon good food. If sheep are kept in rich pastures, twins are more numerous than in scanty pastures. On the bare hills of the western part of Scotland one ewe in twenty has twins ; in England one in three. While a sufficiency of good food is essential, any great excess in the activity of the organs of nutrition is unfavorable. In immature animals the nutritive functions are very active because growth is going on, and such animals are less fruitful than those in full maturity. On the other hand, when the animal becomes very old fruitfulness is less on account of deficiency in nutrition. Young fowls lay comparatively few eggs and these are small and hatch poorly. The young sow has comparatively few pigs in a litter. The quality of feed given to animals influences breeding. A large proportion of sugar in food is generally looked upon as unfavorable. Dry food is less favorable to fecundity than succulent. Mares kept on dry food in stables are less likely to breed than those kept in pastures. Heavy feeding on corn appears to be in general unfavorable, probably because it causes excessive fatness. A marked tendency to lay on fat is usually accompanied by diminished secretion of milk and loss of fecundity. The breeding powers are most active when animals are in

moderate condition, uninfluenced by extreme fat or leanness. The reproductive organs of very fat animals are sometimes affected with fatty degeneration to such an extent as to impair or to entirely destroy the capacity to breed. The failure to breed so often noticed when the female is excessively fat is, however, usually due to the fact that the passages are choked with fat. Many of the breeds of live stock most noted for tendency to lay on fat produce a large number of individuals that fail to breed. The best breeders are usually good milkers. Animals which breed with least difficulty yield the best supply of milk and produce the most hardy and vigorous offspring. Active habits and food sufficient for the wants of the system are most favorable. Exercise of breeding animals is therefore important. This is often neglected in the case of the male. Heredity influences fecundity and, other things being equal, the offspring of animals breeding freely is to be preferred. In the case of twins among cattle, one male and the other female, the female is usually imperfect and is known as a free martin. Such animals seldom or never breed. If a cow has twins both of the same sex whether male or female the fertility is not lessened.

CV — IN-BREEDING.

662. *What in-breeding is* — The term in-breeding, in place of which the expression "in-and-in breeding" is still used by some, indicates the breeding together of closely related animals. No definite rule can be given as to the precise degree of consanguinity which justifies the use of the term; but in general it is applied only in case of the breeding together of individuals more nearly connected by blood than would be perhaps second or third cousins. It is obvious from what has been said that there may be widely varying degrees of remoteness in in-breeding.

663. *In-breeding very general* — In-breeding has been the almost universal practice of all celebrated breeders in effecting improvement, fixing the characteristics, and securing uniformity in all the best breeds of horses, cattle, sheep, and swine, as well as poultry and other domestic animals. Since this is the fact, some have come to the conclusion that in-breeding should be the rule. Even its warmest advocates do not believe in its in-

definite continuance. Breeders have often found it necessary; but they have followed it only as a means to a definite end. They have wished to establish certain well marked characteristics which would better adapt the animals to a particular purpose. They have found it necessary to use in breeding only animals which had the desired characteristics. They have found such characteristics most highly developed only within the limits of a certain family. Hence they have frequently been compelled to breed together individuals belonging to that family. Close relationship was a necessary incident. Close in-breeding should be regarded as a means, not an end. If the pedigrees of celebrated animals be studied, it must be concluded that their breeders evidently intended to breed together animals possessing the desired characteristics regardless of relationship. In-breeding was resorted to only in the case of some favorite animal or animals superior in certain respects to average animals of the herd, with the definite object of securing in the offspring the presence of their most highly valued characteristic. It cannot be expected that a desirable modification — it may be in the direction of improved quality of milk, increased speed, or any other — will show itself in many animals at the same time. It is likely to show itself in one family, or in some one or two animals. It therefore becomes necessary, in order to fix the desirable modification, to breed together animals of the same family.

664. *In-breeding increases prepotency* — There is no fact connected with stock breeding better known than that, other things being equal, the individual whose blood has been longest drawn from one line is most likely to be prepotent. In stock breeding the male is one-half the breeding herd. Prepotency in the male is, therefore, clearly a most valuable characteristic. The breeder can afford to take the utmost pains and to make a large expenditure to secure a male of very superior qualities. A herd or flock can be improved by the use of superior males far more rapidly and far more cheaply than by looking for improvement through introduction of superior females. If the male is more in-bred than the female, he will stamp his likeness upon the offspring to a much greater extent than would be the case were the females of the herd the more in-bred. It is because this fact is so generally

recognized that high-bred males are in such great demand and bring such high prices. It is to be feared, however, that farmers who have not specially studied the laws of breeding are too frequently satisfied to breed to inferior males.

665. *Degree of in-breeding desirable varies* — In order that the male should be prepotent it is usually necessary that he be more highly bred than the female. It is evident, therefore, that the degree of in-breeding which may be necessary to secure prepotency will differ with the breeding of the females with which he is to be paired. For use in a herd where the females are common mixed stock, a pure-bred male, even if not in-bred, is usually prepotent; but in order to effect improvement in a herd in which the females are already pure-bred it is necessary to employ a male of superior qualities and in-bred to a greater extent than the females.

666. *Advantages of in-breeding summed up* — The possible advantages of in-breeding may be briefly stated to be: —

1st. To secure uniformity.

2d. To fix slight desirable variations.

3d. To secure prepotency.

667. *Possible injurious results of in-breeding* — It is not denied that in-breeding injudiciously followed may lead to injurious results. Among those more commonly ascribed to it are: delicacy of constitution, lack of fecundity, and tendency to disease and to abnormal peculiarities. It is no doubt true that in-bred animals often possess one or more of the above-mentioned defects, but the cause is not always to be found in the system of breeding which has been followed. If delicacy of constitution has resulted from the system under which animals have been bred and kept, and closely related animals with such delicate constitutions be bred together, then this tendency to weakness will be intensified; but if related individuals are thoroughly vigorous then delicacy of constitution is not a necessary consequence in their offspring. Neither is a tendency to barrenness always to be ascribed to in-breeding, though it cannot be denied that in many in-bred animals such tendency is quite marked. It is perhaps most noticeable among the breeds of cattle, hogs, and sheep which have a marked tendency to lay on fat. It

has been pointed out (661) that excessive fatness is unfavorable to fecundity. By in-breeding individuals belonging to a family with unusual tendency to lay on fat, as that tendency is increased, a tendency toward barrenness would doubtless also be increased. In in-bred families of the dairy breeds barrenness is much less common than among the beef breeds. Loss of fecundity does not seem then to be a necessary consequence of in-breeding. The argument in connection with disease is essentially the same. If the parents be healthy, though closely related, there is no probability that disease will be transmitted to offspring, but if there be a tendency to disease in the families and in-breeding be followed that tendency is increased. The conclusion must be that close breeding in itself is not injurious, but that it tends to fix and perpetuate constitutional defects produced by other well known agencies and should not be practiced by careless or inexperienced persons.

The chief objection to in-breeding is the difficulty of selecting animals free from constitutional defects and the danger that such defects will be intensified in the offspring. In-breeding is, however, a most important means of improvement when judiciously practiced, and constitutes the only known method of securing an accumulation of slight variations in any particular direction which it may be desirable to retain and perpetuate.

CVI — CROSS-BREEDING.

668. *Cross-breeding defined* — Cross-breeding, strictly speaking, is the pairing of animals of distinct breeds, but the term is also sometimes used to signify the pairing of animals of different families of the same breed.

669. *Advantages in cross-breeding* — Cross-breeding is often a useful practice. The statements concerning the origin of the different breeds of horses, cattle, sheep, and swine have made it evident that it has been very much practiced in the improvement of a very large number of these breeds. Let us take a single example only. Hampshire sheep were originally horned, large boned, with high withers and sharp spine. They were crossed with Southdowns and the breed was made hornless, broader backed, rounder in the barrel, shorter in the leg, and superior in practically all

valuable qualities. In all instances where a breed has been improved by crossing such improvement was due, not to the fact that the males used were of another breed, but because they possessed superior qualities and were much higher bred. Marked improvement from crossing follows only when the males selected for the purpose are more highly bred than the females with which they are paired. Some breeders in Scotland made the attempt to improve a very old mountain breed, known as the Black-faced sheep, by crossing with the Cheviot, but their efforts were attended with little success, for the blood of the Black-faced sheep was purer than that of the Cheviot and was therefore prepotent. Breeders in France at one time made the effort to improve their sheep as mutton animals by crossing with rams of some of the English mutton breeds, only to find that the latter effected little improvement. The French stock was of the older and purer blood. Having made this discovery the French breeders crossed two of their native breeds and then used the English rams with the cross-bred native ewes. The result was entirely satisfactory. The rams were now of the purer blood and they were prepotent and improvement was marked. If a male of mixed blood be paired with a female of pure blood, even though he be greatly her superior, little improvement is likely to follow, for the blood of the female is prepotent.

670. *Extent to which cross-breeding should be followed* — From what has preceded it will be clear that cross-breeding like in-breeding should be regarded as a means,— not an end. It should be followed only with a definite object in view. That object must always be improvement of the stock in some special direction. Cross-breeding should be followed only so long as the breeder finds males superior to his general stock of the breed which he is striving to improve.

671. *Crossing animals of two distinct breeds* — The pairing of animals of two distinct breeds is sometimes desirable for the accomplishment of special objects, but if the two breeds are of about equal age and purity the results are likely to be somewhat unsatisfactory. The characteristics which the two breeds have in common are likely to be transmitted to the offspring, while the special characteristics valued in each breed, and different in the two

which perhaps the breeder seeks to unite, are rather likely to be lost. This may not be the case if the two breeds crossed are somewhat allied or similar in general characteristics. The greater the contrast between them and the greater the degree of specialization, the greater the tendency in this direction. The offspring of a cross between two distinct breeds is known as a cross-bred animal or a cross-breed. It is seldom advisable to pair males and females which are the offspring of the same cross. A cross-bred animal, as has been indicated, may sometimes be valuable, combining many of the good characteristics found in the two breeds. Thus, for example, the Holstein-Friesian and the Jersey cross among cattle often produces a valuable dairy cow. The quantity of milk is greater than from the pure-bred Jersey and the quality is better than from the pure-bred Holstein. Under some circumstances crossing these two breeds, then, may be advisable; but to breed together males and females resulting from such a cross or any similar one is never advisable, for the reason that such animals have little capacity to transmit their own characteristics to offspring. If they be paired there is the utmost uncertainty as to what the character of their offspring will be. There is strong probability that it will show a tendency to revert to some remote ancestral form (atavism, 656).

672. *Production of grades* — The term grade is applied to the offspring resulting from pairing a pure-bred male with females of mixed or uncertain blood, although in the first two generations the terms half-blood and three-quarters blood are in general use. Thus, for example, if a pure bred Jersey bull be crossed on a common or mixed blood cow not known to contain any blood of the Jersey the offspring is a Jersey half-blood. If a female Jersey half-blood be paired with a Jersey bull the offspring is a Jersey three-quarters blood. The term seven-eighths blood might be used to designate the offspring of the next generation from a similar course of breeding; but more commonly such animals are known as Jersey grades. To designate an animal containing a proportion of Jersey blood exceeding three-quarters or seven-eighths, the term high grade is generally used. It is evident that the greater the number of generations in which such a course of breeding as we are considering is continued, the larger becomes the proportion of Jersey

blood. Mathematically speaking, the product of such a course of breeding never becomes pure Jersey. Practically speaking, we may say that when the proportion of Jersey blood becomes as great as thirty-one thirty-seconds the difference between the animal and one of pure blood is so small that for any ordinary use it may be disregarded. Most breeders' associations, however, will not accept such an animal for registry. The use of pure-bred males upon the mixed stock of America has been a most common course of breeding, and has resulted in enormous improvement in all classes of domestic animals. By selecting pure-bred males of superior qualities we may count on their transmitting their characteristics to offspring, when paired with grade females, in unusual degree. It is believed that, in the process of grading up their stock, farmers not infrequently, from motives of false economy, give up the use of pure-bred males much earlier than is advisable.

The grade male is far less certain to stamp his likeness upon his offspring than is the pure-bred animal, and the longer the process of grading up is continued the greater is the necessity of well-bred males, for only such will be prepotent.

673. *New breeds not produced by crossing two distinct breeds* — Such facts as have been given concerning the history of the different breeds of live stock have perhaps sufficed to make evident that at least in the case of all breeds which have originated within historic times, *i. e.*, of all breeds the particulars of whose production are well known, the blood of more than two breeds has been combined. By such combination or by the use of a pure-bred upon a foundation mixed in its origin a new breed may result ; but to attempt the production of a new breed by the combination of two pure breeds would be unwise.

CVII — RELATIVE INFLUENCE OF PARENTS.

674. *Theories* — Many theories have been advanced concerning the relative influence of the sire and the dam upon offspring. It was formerly quite generally believed that it was possible to parcel out the young animal between the two parents ; that certain of its peculiarities could be always

definitely traced to the sire, others as definitely to the dam. Such theories are not at present accepted. No such definite laws of influence appear to hold.

675. *The best bred parent exerts most influence* — If other things are equal, it appears to be generally true that the parent which is best bred, the one whose blood has been longer kept pure, exerts the greater influence in determining the characteristics of the offspring (664).

676. *The relative vigor of parents may exert an influence* — The extent to which either parent transmits its characteristics to its offspring appears to depend in very marked degree upon the comparative strength of constitution and physical vigor of the two. Under otherwise similar conditions the parent which is most vigorous influences the offspring in greater degree. Constitution and vigor, in some cases, appear to be even greater factors in determining the degree of power possessed by an individual to transmit its characteristics than does purity of blood. Still, in all cases where difference in constitution and vigor is not marked, the parent which has the purer or the least mixed blood exercises the greater influence.

677. *The relative age of parents* — The relative age of parents may have a considerable influence in determining the extent to which the offspring will resemble the one or the other. The influence which is due to age is, however, very closely connected with that considered under strength of constitution and physical power ; for age probably exerts an influence only as it affects vigor.

678. *The amount of service of the male* — The excessive use of the male for breeding purposes impairs his powers of procreation and without doubt diminishes his capacity to transmit his qualities.

679. *Qualities belonging to one sex may be transmitted by the other* — It is important to point out that the male appears to be quite as likely to transmit qualities belonging to his female ancestry as he is to transmit the qualities belonging to himself or to his male ancestry. Indeed, in the opinion of many he is rather more likely to do this. That such is the case, however, may be doubted. It is, however, to take an example, well known that a bull of a milking breed is likely to transmit the qualities of his dam in

remarkable degree. His female offspring are likely to show the form of udder of his dam and to show the same peculiarities as regards both quality and quantity of milk, disposition, etc. The granddaughters of a cow by her son are quite commonly more nearly like her than her own daughters. The same rule appears to be equally true as regards other breeds among cattle and other animals.

680. *The relative influence of parents cannot be determined in advance* — While the principles enunciated are well established as general principles, they are only such,— they are not invariable rules. It is doubtless true that, when the male is of pure blood, when he is vigorous, when he is in the full maturity of his powers, he is likely to transmit his characteristics in remarkable degree. But whether he will do so cannot certainly be foretold. It follows, therefore, that it is a great advantage to breed from sires of known power in this respect. When a male among any of our domestic animals or breeds of animals is found to stamp his likeness to a remarkable degree upon offspring, he must be looked upon as an animal of unusual value, and he should be used for breeding purposes as long as possible. Breeding from tried sires of approved excellence is much to be preferred, to breeding from untried sires, however excellent the latter may apparently be.

CVIII — INFLUENCE OF PREVIOUS IMPREGNATION.

681. *Such influence a fact* — The influence of the male does not appear to be limited to his immediate offspring but extends through the female which he has impregnated to her offspring by another male, or at least it may so extend. There are too many well-established instances where this influence has been observed to leave its possibility a matter of doubt. Where mares are first used for mule breeding and later for breeding their own species the foals have frequently been observed to show some of the peculiarities of the mule, such as longer ears, narrower body, etc. Polled cows bred first to horned bulls have later produced calves which grew horns when served by polled bulls. White-faced ewes bred first to rams of a black-faced breed have not infrequently produced black-faced lambs when bred later to rams of their own breed. On the other hand there are many instances

when any such influence fails to show itself. It cannot then be regarded as by any means certain and yet as it is a possibility it must be considered.

682. *The blood of the mother not contaminated* — It was formerly held that if the female of one breed should produce offspring by a male of another breed she would no longer be an animal of pure blood ; that as her offspring partook of the blood of the sire so her own blood was influenced by that of the sire. This does not appear to be the case. There is no direct communication between the circulation of the mother and the fœtus. It is not even yet clearly understood to what the influence in question is due, although there is much evidence which tends to confirm the belief that it is far more likely to manifest itself in the case of those animals where the attachment of the placental membranes surrounding the fœtus to the walls of the uterus is large or in successive conceptions the same. In the mare the connection between the placenta and the interior walls of the uterus extends over its entire surface, and the influence of a preceding impregnation is probably more often noticed in the case of the mare than with any other animal unless it be the bitch.

Recognizing that it is a possibility that the offspring of a pure-bred female by a male of the same breed may show some of the peculiarities of a male of a different breed, providing the female has previously been paired with such an animal, many breeders carefully avoid pairing pure-bred females with males of any other breed. It appears to be true, however, that the cases where no such influence can be traced so far outnumber those in which it shows itself, that this matter can be regarded as of little importance, and if, as sometimes happens, it is a matter of convenience or perhaps of important economic advantage to pair a pure-bred female with a male of another breed, the breeder need not hesitate to do this through fear that the female will thereby become unfitted for producing well marked offspring of her own breed.

CIX — MENTAL INFLUENCES AND NERVOUS IMPRESSIONS.

683. Much has been said and written concerning the possibility that offspring will be marked as a result of nervous impressions at the time of

conception or during the period of gestation, and so many are the instances where such influences have been noticed that we cannot doubt that it is a possibility; but on the other hand it may be said that the probability that offspring will be marked as the result of such impressions seems on the whole to be rather remote. In proof that such an influence occurs, numerous instances have been cited of mares producing colts that resembled in color the horse with which the mare continually worked, although the dam herself and the stallion were of an entirely different color. It has been claimed that in some instances a lot of pure-bred heifers in calf to a bull of the same breed running in pasture with heifers of an entirely different color have produced offspring in color similar to the animals with which they were pastured. Such instances as these, and many more which might be cited, are sometimes well authenticated, but there is much speculation and a great deal of guessing in such matters. It is, moreover, significant that such unusual markings are seldom anticipated; they occur and then someone ingenuously makes a theory to explain them. On the whole it may be said that such effects are uncertain and so improbable that the breeder may safely ignore them.

684. *Controlling the sex of offspring* — There is perhaps no subject connected with stock breeding which has excited more discussion than the question of the possibility of controlling the sex, and innumerable theories have been advanced. None of these theories can be considered established. Breeders have sometimes reported facts which, in their opinion, seemed to prove a theory, but investigation usually convinces an impartial mind that the evidence is founded upon an experience of too short duration. The fact appears to be that the rules which determine the sex of offspring are not known. There is nothing which the breeder can do which will have an influence in this direction.

685. *The relative size of sire and dam* — For many years writers claimed that in stock breeding it was unwise to pair with a female a male much larger than herself. The reason offered in explanation of this principle was, that in case animals should be so paired the danger of difficulty in parturition was increased. It may be doubted whether this view is con-

firmed by the facts. The writer, while in Japan, has seen bulls 2,000 pounds in live weight bred to cows of not more than 600 pounds, and never knew of a case of difficult parturition. Similarly stallions from the United States and from other countries weighing from 1,200 to 1,300 pounds were continually bred to mares weighing not over 600 pounds, and cases of difficult parturition were exceedingly rare. The size of the offspring at birth appears to be determined mainly by the dam, though its subsequent development is, of course, influenced by the sire. It appears to be nature's law that the male should be larger than the female. His excess in size as compared with the females of the same breed is considerable in the case of all our domestic animals. It is not recommended to mate together animals differing too widely. Within ordinary limits, however, the breeders need not hesitate to mate animals on account of differing size.

CX — THE SELECTION OF INDIVIDUAL ANIMALS FOR BREEDING.

686. *The value of pedigree* — A pedigree is a record by which the ancestry of an animal can be traced backward from generation to generation. Such a record, provided it is accompanied by definite information concerning the characteristics and performances of the animals shown in the pedigree, is of great value in enabling one to select breeding animals intelligently and wisely. Undue importance is sometimes attached to length of pedigree. It does not necessarily render an animal more valuable because his descent can be traced for a large number of generations, even if it extends back to some very distinguished progenitor. The value of the pedigree is determined more largely by the quality of the immediate progenitors, — the sire, dam, grandsire, and grandam. True, the longer the line of excellent ancestors, the more likely will be the offspring to inherit ancestral characteristics, but the nearer the "top" of the pedigree the rare individuals occur the more valuable it is. The best pedigree is one that produces the best animals. It must be good now and not a few generations back.

687. *The male is half the herd or flock* — That the male is half the herd or flock has been pointed out in another place (664). So important is the

recognition of this fact that attention is once more called to it in connection with our present subject. Too great care cannot be taken in selecting males which are to be used for breeding purposes. By wise selection here, steady improvement can be easily maintained. With failure to select wisely here deterioration in the quality of the stock must be the result. As a rule it will be found best to select for breeding purposes a male of all-round excellence, rather than one which is extra strong in some one or a few directions, unless it may be that the females are lacking in that direction. In attempting to improve a breed of live stock, keep in mind that if animals accustomed to favorable conditions of shelter and food are taken to a locality where the conditions are less favorable, deterioration generally follows. On the other hand, remember that if conditions can be made better than those to which any stock has been accustomed this in itself will have an important influence in favor of improvement. In deciding what pure breed to use in grading up common stock, keep these facts in mind; and study, moreover, the conditions under which the different pure breeds have been produced, selecting, other things being equal, a breed accustomed to conditions of elevation, soil, climate, food, and care such as those which you can give.

688. *Mutual adaptation of male and female* — It has been pointed out in another connection that it is wise to test males which are to be used for breeding purposes, and when one is found that begets good stock he should be used as long as possible. The quality of the stock begotten by a male is not determined always by the fact that the male himself is an animal of excellent quality and the female likewise. In some cases, though both sire and dam are animals of very superior excellence, their offspring proves disappointing. This seems to be due to the fact that oftentimes, perhaps for reasons which cannot be perceived, the qualities of sire and dam, though each seems a superior animal, are not such as will unite in the offspring. Breeders use the word "nick" in this connection. They say of a certain combination of blood, "It nicks," meaning that the results are entirely satisfactory. It sometimes happens that certain strains of blood invariably fail to "nick." When such facts are known the pairing of animals belonging to these strains should be avoided.

CXI — DETAILS OF STOCK BREEDING.

689. *Proper age* — In the statements which follow, concerning the age for beginning to breed from females of the different kinds of domestic animals, the age designated is that when the young should be brought forth, not that when the animal is to be paired.

(*a*) *Neat cattle* — For milking breeds, females from 2 to 2½ years; for beef or working breeds, females 2½ to 3 years. The capacity to give milk appears to be developed by rather early breeding. Hence most breeders of dairy stock, although they recognize that the heifer is by no means full grown at the age of two years, prefer that she shall produce her first calf at about that age. It is then good policy — with the best of food and care — to allow somewhat more than the usual interval before breeding again, meanwhile milking the heifer as long as possible in order to fix the habit of persistent milking. Many prefer, therefore, that the second calf should not come within less than one and one-half years from the first. Beef breeds, on the other hand, should not be bred as early, for here size and maturity of form are of greater value than milking qualities. In the management of beef breeds, however, there appears to be considerable danger that if breeding be too long deferred the animal will become excessively fat and may prove barren. Cows may be used for breeding until reaching the age of from 18 to 20 years, but the best period is between 4 or 5 and about 12 years. Bulls may be used for breeding purposes as early as from 1 to 1½ years and may continue fit for breeding up to the age of 14 or 15 years. The best age lies between 3 and 10 years. It is not a general custom among breeders of live stock to keep bulls, unless of exceptional value, beyond the age of 4 or 5 years. This appears to be due largely to the fact that they so frequently become vicious with increasing age. There can be little doubt that breeding from immature bulls will be attended with loss of constitution and vigor.

(*b*) *Horses* — The breeding age for mares lies between about 3 and 20 years, in most cases the best period being from about 5 to 15 years. For stallions the breeding age extends from about 3 to 20 years, though oc-

casionally stallions of unusual value have been used for breeding purposes until over 30 years of age.

(*c*) *Sheep* — The breeding age of sheep for different breeds varies considerably. Southdowns (and most of the Downs) mature comparatively early and may be bred correspondingly early. The ewes of this breed are often bred at one year, although most of the best breeders prefer to wait one year longer. For Merino ewes the age for beginning breeding is 2 years; for other breeds it may vary from 1 to 2 years, according to feeding and growth. Ewes continue in breeding condition as a rule until about 8 or 9 years of age, but their best period is from about 3 to 6. For the ram the breeding age ranges from about 1½ or 2 years to 8 or 10.

(*d*) *Hogs* — Sows are usually first bred at one year and in the majority of instances are used for breeding only until about 3 or 4 years old, apparently because the old sow does not fatten well. A good brood sow once discovered should be kept as long as she continues to bring good litters. Boars are used for breeding purposes as early as 6 months. The best age is from about 1 to 4 years, while animals of exceptional qualities sometimes continue in service much longer.

690. *Number of females to one male* — The number of females which may be safely bred to one male within the period of a year varies quite widely with the age, vigor, feeding, and general management of the animal, and also to some extent with the length of the breeding season. Experience indicates the following rules to be usually safe: —

To the bull, 50 to 60 cows.
To the stallion, 50 to 75 mares.
To the ram, 50 to 60 ewes.
To the boar, 15 to 20 sows.

691. *The period of gestation* — The period of gestation is the length of time which the young is carried. This is influenced to some extent with all animals by size, by length of time required to reach maturity, and by inherited tendencies. It is somewhat different for different breeds of the same animal.

Among sheep it is, for Southdown about 145 days, for Merino 150 days.

For the cow the period usually ranges between about 270 and 290 days, the average being about 282 days.

For the mare the period ranges from about 320 to 340 days, the average being about 330 days.

For the sow the time is about 112 to 120 days, the average about 116 days.

692. *Management during pregnancy* — Pregnancy is the name given to the period during which the young is carried. During this period the females of all classes of domestic animals should receive careful attention. The feeding should be such as is calculated to bring them into moderately high condition without excessive fatness. Excessive fatness is likely to cause difficulty at time of parturition ; but a moderate amount of fat is desirable, because milk secretion taxes the system heavily and fat which has been previously stored up may be drawn upon to support the animal during this trying period. This matter is of especial importance in connection with breeding sows, on account of the numerous young and their commonly vigorous appetites.

Exercise during this period is valuable. Difficulty in parturition is far more likely to occur with animals kept constantly in close confinement during this period. Such an amount of exercise and freedom is desirable as is conducive to best health. Mares may be worked during pregnancy if the work be moderate and the animals carefully managed. Violent work, whether at rapid driving or at draft, must be avoided, as it will be likely to cause sprains and consequent abortion. All conditions which are liable to lead to violent exercise, such as turning animals out to run at will after long confinement, all conditions which are likely to cause slipping or jumping, all occasions of fright, should be avoided, for these may lead to the premature birth of the offspring. Yards in which pregnant animals are exercised should have an even surface, and care should be taken not to allow such animals in yards covered with ice.

In case of cows when, as is usually the case, confined in stables a large part of the time, the platform should be level or nearly so. If the platform slopes to any considerable extent to the rear, unnatural pressure is brought to bear upon the uterus and abortion sometimes follows.

There are certain kinds of food which should be carefully avoided because likely to cause abortion. Among these grasses, straw, or grain containing ergot are among the most important, but the feeding of mouldy hay or of frosted or decayed roots or unsound food of any kind must be looked upon as more or less dangerous.

693. *Management at time of parturition* — Parturition is the name which designates the bringing forth of the young animal. At and just before this time the females among all animals need careful attention. The food for a little time before parturition should be made lighter and particular care should be taken to keep the bowels open by the use of laxative foods. Roots are especially useful at this time. Several days before expected parturition the female should be given a separate pen, large enough to allow free movement and turning. This is an absolute essential in the case of cows, mares, and sows when kept in confinement. It is not essential for ewes, although it may be safer, as the young are less likely to stray to a distance from the dam. As the time for parturition approaches the breeder should be watchful. If the presentation of the young is normal, assistance is not usually called for, but in case of false presentation help must be promptly rendered if it is to prove of service.

CXII — THE PRINCIPLES AND PRACTICE OF FEEDING.

694. *Knowledge of scientific principles essential to the highest success* — There have been, and without doubt there are, many very successful feeders entirely ignorant of science. They owe their success to love for their animals, to shrewd observing powers, and to experience both inherited and acquired. So, too, not a few of our prominent men have won enviable success in life with little schooling. Shall we say that they were successful because they had little opportunity for school? Was it not rather in spite of the disadvantages of such privation? All agree that schooling helps a man of natural ability, and, in the same way, some knowledge of the composition of animal products and of foods, some knowledge of the laws of nutrition, and of the facts discovered by scientific men regarding the most economical production of meat, of fat, of milk, and work will help even

the best practical feeder. Such knowledge will not render the exercise of the observing faculties and of the judgment the less important. It will rather sharpen the one and broaden and deepen the other.

695. *Analogy between the vegetable and the animal worlds* — It has been pointed out that for the nutrition of plants certain elements and compounds are necessary (18). We know that each compound and element serves certain definite ends; that, except within very narrow limits, one cannot be substituted for another. Plants, as has been made clear, are not nourished by soils, by manures or by fertilizers, as such; but take from them all certain essential compounds. We know that there must exist a certain rather definite proportion between the different plant food compounds for economic plant production; that, for example, it would be folly to go on stocking a soil already rich in it with nitrogen in the hope of satisfying the plant's hunger for potash. The principles of animal nutrition are similar. In a certain sense animals are not nourished by foods consumed—by hay, by grain, by roots—as such; there exist in these and other foods certain essential food compounds known as nutrients. These nutrients each serve certain definite functions. For the economical production of lean meat they are required in definite quantities and proportions; for the production of fat in equally definite but different proportions; and the same is true concerning the production of milk and of work. One must have definite knowledge as to what the animal body and animal products contain and must know what constituents in foods may be used to form them, as well as to carry on the life processes, before one can feed most wisely under all conditions.

CXIII — COMPOSITION OF THE ANIMAL BODY AND OF ANIMAL PRODUCTS.

696. *The classes of compounds named* — The animal body contains many widely differing tissues (bones, flesh, brain, hair, etc., etc.), and both the body and such products as milk and wool contain many complex compounds. For the purpose of study of the principles of feeding all may be included under the following heads: water, ash or mineral matter, protein, and fat.

697. *Water* — Water is the most abundant constituent of the animal body, the proportion varying from about 40 to 85 per cent., according to condition and age. The body of the young animal contains more water than that of the older animal. The body of a very fat, mature animal contains the lowest percentage of water. Water is of course indispensable to animal life, but from the standpoint of feeding it is not of direct economic importance and need not be considered at length.

698. *Ash* — The ash or "mineral matter" is the residue after complete burning. From about 2 to 5 per cent. of the gross weight of the animal body is mineral matter. Most abundant among its constituents is phosphate of lime, though there are smaller quantities of numerous other elements. In the absence of a sufficiency of mineral elements no animal can maintain health. Though small in amount, they are absolutely essential. Fortunately, however, it is not usually important to take them separately into consideration, for the reason that with no ordinary combination of foods is there likely to be an insufficiency of them.

699. *Protein* — The word protein does not designate a definite chemical substance. It is a general term applied to numerous compounds which make up parts of the bones, cartilage, muscles, skin, hair, wool, feathers, etc. All the compounds included under the term protein are alike in containing nitrogen, which is usually present to the amount of from about 16 to 17 per cent. The casein of milk, the white of the egg, and dry, lean meat belong to this class. In speaking of protein Hills says: "The flesh, skin, bones (in part), vital organs, brain, nerves, in fact the bodily mechanism are made up of protein diluted, so to speak, with water, supported by the ash of the skeleton and rounded out with fat. It is obvious that protein is of the utmost importance." *

700. *Fat* — Fat is ordinarily found in all parts of the body, also in milk, and though not a part of these tissues themselves, it is associated with hair, wool, etc. Fat commonly constitutes from 6 to 30 per cent. of the live weight of animals. Fat contains carbon, hydrogen, and oxygen, but no nitrogen. Its elements are derived primarily from the air, for the plant

* Bulletin 81, Vermont Experiment Station.

furnishes the material from which the animal derives its fat, and the atmosphere is the source from which the plant gets them (20, 21, 22). Fat is not equally as necessary to life as the other three classes of constituents considered. It is, nevertheless, of much importance and in some of the animal products it possesses high value (butter).

701. *Source of the compounds of the animal body and of animal products* — It may possibly be superfluous to call attention to the fact that all these substances found in the animal body and in animal products are formed from nutrients in the animal, vegetable, and mineral materials known as foods, which the animal converts into bone, flesh, fat, milk, and work.

CXIV — COMPOSITION OF FOODS.

702. *Classes of compounds* — In foods we find, as in animals, water, ash, fat, and protein, and these have the same essential characteristics whether found in the plant or in the animal. In vegetable foods we find in addition crude fiber and nitrogen-free extract matter.

703. *Water* — Even apparently dry foods such as hay, straw, and grains contain water, the amount varying usually between about 8 and 15 per cent. Green foods, such as corn fodder, oats and peas, etc., contain much more, usually from about 75 to 85 per cent. Some of the roots contain the maximum of water found in animal foods, occasionally as high as 90 per cent. The proportion of water, especially of coarse foods, may affect their palatability and their special influence on the animal or on its products, but it in itself, as a constituent of the food, has no nutrient value.

704. *Ash* — The ash of animal food is composed chiefly of lime, potash, soda, magnesia, iron, phosphoric acid, and sulfuric acid. The proportion of ash in different foods varies widely. It is relatively abundant in grass, hay, and green fodders, and milk ; and comparatively deficient in corn.

705. *Fat* — The figure which is commonly given under the heading "crude fat" in a statement of the composition of the fodders, covers a number of other materials besides pure fat. In fodder analyses the crude fat is determined by the use of ether, which dissolves, besides fat proper, a certain amount of wax, resin, and the green coloring matter of plants, pro-

vided these substances are present. Crude fat, then, is fat mixed with the substances just named, and because the term crude fat may under some circumstances be misleading the term ether extract is sometimes used to designate this mixed material. So far as is known it is not important to separate the fat found in foods from the other substances named, because they apparently have about the same food value.

706. *Protein* — The term crude protein, as commonly given in tables showing the composition of foods, includes both the true albuminoids and amides. The gluten of wheat is an example of vegetable protein. It is the part of wheat which after careful chewing in the mouth is left behind as a kind of gum. Most seeds and their by-products contain considerable quantities of this or a similar constituent. Vegetable-like animal protein contains a large percentage of nitrogen and, as will be seen, it is the most important constituent of foods. Amides have much less value for foods than albuminoids.

707. *Crude fiber* — This includes the framework of the plant — the woody part, the cell walls. Crude fiber is particularly abundant in such foods as hay and straw. It is also abundant in the hulls of seeds. Crude fiber is digested to a considerable extent by ruminants such as the cow and the sheep, to a considerably less extent by the horse. Hogs digest crude fiber quite freely; but there are no data on the basis of which they can be compared with the other animals in this particular. Crude fiber is the least valuable of the nutrients contained in foods.

708. *Nitrogen-free extract* — Under this term are included a group of compounds containing a number of substances all of which are dissolved and extracted by the use of weak solvents, hence the name "extract" designates this group; and it is further called "nitrogen-free" because none of the compounds included in it contain nitrogen. Among the most common substances included in this class are starch, sugar, and gums. Starch is usually the most abundant in all concentrated cattle foods. So far as it is digested crude fiber serves similar purposes in the animal economy to those served by the nitrogen-free extract substances, and a common name is sometimes used which includes both. This name is carbohydrates. It must not

be concluded from what has been said that crude fiber has the same value as starch, sugar, etc., pound for pound. This is far from being the case, because it is not digested to anywhere nearly the same extent. It is that portion which is digested simply which is commonly combined with the digested starch, sugar, etc., under the name digestible carbohydrates.

709. *The constituents which the feeder must consider* — In other connections it has been made evident that ash is commonly abundant and that we do not depend upon food for water. It follows, then, that the feeder has only to consider the protein, fat, and carbohydrates. There is thus a further analogy between plants and animals. We have seen that in feeding plants the farmer has usually to consider only nitrogen, phosphoric acid, and potash,— three food elements ; so in feeding the animal we have to consider three nutrients, and the problem is to determine in case of the animal what amounts of these nutrients will best serve the purpose in view, as the problem in feeding plants is to determine what amounts of nitrogen, phosphoric acid, and potash should be supplied.

CXV — FUNCTIONS OF NUTRIENTS.

710. *Difference between food and nutrients* — Food is any material which, on being digested and assimilated, is capable of forming or repairing tissues or yielding energy. Food must supply all the needs of the body. A food usually contains all the classes of nutrients. Each nutrient has certain distinct functions. Only those nutrients will be here spoken of to which the feeder must give especial attention,— water and ash being omitted.

711. *Protein* — "Protein," says Hills, "is a flesh-former, the machine maker, the repairer of wear and tear." Protein may also be used in the body as a fuel to maintain the temperature of the body, but to feed in such a way that protein must be used as fuel is not wise, as it is too costly. Fat and carbohydrates are far cheaper fuels. The feeder who so manages that the animal must burn protein would be about as unwise as the householder who should select as fuel for his stove mahogany or curled maple when ordinary woods or coal would serve the purpose just as well and at much

less cost. The functions of protein are five. The statement as to what these functions are is quoted from Hills.*

"(*a*) From protein are formed flesh, tendons, cartilage, etc., and the nitrogenous part of milk (casein, albumen, etc.). The primary function of protein is that of tissue building. This tissue may be the flesh of the growing animal, the repaired or rather replaced flesh of a mature beast, the wool of a sheep, or the milk of a cow which, in part at least, is made from broken down udder tissues. Without protein no flesh, hair, wool, or milk can be made. Animals fed on materials devoid of these nutrients have starved in the midst of plenty.

"(*b*) It forms body fat and perhaps at times milk fat.

"(*c*) It furnishes material for the production of heat to maintain the warmth of the body.

"(*d*) It furnishes material for the production of muscular energy.

"The three functions last named (fat formation, heat making, and the production of muscular energy) are usually performed by the fat and carbohydrates of the food. If, however, these are insufficient in amount, protein may be consumed in their stead. Such shortage rarely occurs in cattle feeding except when a ration is deficient in all the nutrients, that is to say when animals are partially starved. Protein may be used, in a similar way, instead of fat or carbohydrates if it is fed in excess of what is needed for making tissue or replacing waste. The protein thus used may be that of the food or that of the body, *i. e.*, flesh. The more is fed, the more is destroyed by the vital processes, if fed in excess of requirements. These three functions, however, may very properly be termed the secondary functions of protein, since these offices can be performed more successfully and more cheaply by the carbohydrates; and, as has been already observed, in ordinary feeding practice they are more commonly thus performed.

"(*e*) Protein is considered by some to be a stimulant to milk production. It has long been known that, within certain limits, the more highly nitrogenous the ration, the greater its value as a milk maker. Protein, in other words, seems to act somewhat in the manner of a milk stimulant. Average

* Bulletin No. 81, Vermont Experiment Station.

milk carries from 3 to 3.5 per cent. albuminoids. A cow giving 30 pounds of milk a day yields therein a pound of protein (casein and albumin). The fat and sugar may be formed otherwise, but casein and albumin can only result from protein feeding. The protein content of a ration, more than any other one thing, governs its effect upon the milk flow."

712. *Carbohydrates and fat* — The functions of carbohydrates and fat are so similar that they may be considered together. These functions are five. Again quoting Hills: "They furnish material for the following purposes: —

"(*a*) *The production of heat* — Carbohydrates and fat serve as the main supply of fuel wherewith to maintain bodily heat. A certain temperature is necessary for the functional activities of the animal body. If it falls below or rises above a certain point, death generally ensues. This heat is kept up by the destruction or burning of certain nutrients in the body. If sugar or starch were burned in a stove, they would evolve heat, and would form, among other things, carbonic acid gas. If, instead of being burned, the starch and sugar were eaten, they would be consumed by the vital processes of the animal, the same amount of heat would be formed, and the same chemical compounds would result as in the burning. Combustion would be slower, but the results would be the same.

"(*b*) *The production of muscular energy* — Carbohydrates and fat are burned not only to keep the body warm but to produce the energy used in muscular motion. The analogy of these nutrients and the muscular system to coal and the locomotive is close. Any decided exertion of the body is accompanied by much increase in the expenditure of carbohydrates and fat. The nitrogenous materials suffer but little loss. Of course they are necessary, yet the carbohydrates appear to be most vitally concerned. Fat more than any other one constituent of the body appears to be available for this purpose. It has for this, for the heat producing function, and for fat storage, from 2.25 to 2.5 times the value of carbohydrates.

"(*c*) *The formation of body fat* — If there be eaten an excess of these nutrients over what is required for the production of heat and force, storage as fatty tissue may take place. Either nutrient may be used for this purpose.

"(*d*) *The protection of the flesh of the body from too rapid breaking down as a result of vital processes* — These nutrients, when digested, serve to protect the more costly protein from over-consumption by the vital processes. As has been pointed out hitherto the several functions of the carbohydrates and fat may be performed by protein. These secondary functions are held in abeyance, however, when the carbohydrates and fat are present in proper quantities.

"(*e*) *The carbohydrates are probably a main source of material for the manufacture of milk fat* — The ultimate source of the fat of milk has been in controversy for years. Protein, food fat, and carbohydrates have all been urged as the causal nutrient. While this point is perhaps not fully settled, Jordan's results go far towards proving that carbohydrates are mainly concerned in the formation of milk fat, since, in his experiment, a cow was fed for three months on a ration containing less than 6 pounds of digestible fat, yet she gave in her milk 63 pounds of fat. This extra fat could not have come from previously stored bodily fat, since the cow gained 47 pounds in weight, and was judged to be fatter at the end than at the opening of the trial.

"There is no one function of the carbohydrates and fat which, like the flesh-forming function of the protein, can be considered of more consequence than the others; all are of the utmost importance to the animal economy."

CXVI — DIGESTIBILITY.

713. *Digestibility explained* — In ordinary language we speak of foods as being digested. As a matter of fact no food, and as a rule no single nutrient of a food, is completely digested. A part only is actually digested. That part which after being eaten is brought into such condition that it can be either dissolved or directly taken up by the absorbent vessels of the stomach or intestines, thus becoming a part of or mixing with the blood, is the only part which is truly digested. It is only the part of the food which is actually digested which is of direct importance to the animal, so far as its nutrition is concerned; although the portion which is not digested may serve a very important function in providing suitable bulk to properly fill

and distend the stomach and intestines. The dung of all animals consists almost entirely of the undigested portions of the food. The extent to which any food or nutrient is digested is determined by first ascertaining the amount consumed by the animal and then by examination of the dung determining the amount of the same nutrient in that. The difference between the amount of the nutrient in the food consumed and the amount in the dung is the proportion digested. Pure nutrients, such as protein, starch, sugar, fat, would undoubtedly be wholly digested, but these nutrients never occur pure in common cattle foods. They are associated with varying amounts of woody fiber and other materials which prevent their perfect or complete digestion. Various conditions may modify the extent to which a food is digested.

714. *Conditions affecting digestibility* — The conditions which affect the extent to which foods are digested must be considered under two subdivisions : —

1st. Digestibility as affected by the animal.

2d. Digestibility as affected by conditions pertaining to the fodder.

1. *Digestibility as affected by the animal.*

(*a*) Horses digest crude fiber and fat less perfectly than do ruminants, but protein and carbohydrates are digested about equally well by all these animals. Crude fiber in certain foods is well digested by hogs but, on the whole, probably less perfectly than by cattle and sheep. There is not much difference in the extent to which the two latter animals digest different foods.

(*b*) *Breed* — There is no well-defined difference in the extent to which animals of the same species of different breeds digest foods of different kinds.

(*c*) *Age* — Within such limits as those within which the animal maintains a condition of vigorous health, there is no difference in the extent to which foods are digested which can be ascribed to age.

(*d*) *Individuality* — Different individuals among our domestic animals of all kinds and breeds possess quite widely differing capacity to digest their foods. The differences due to individual variations are greater than any which have been traced to breed.

(*e*) *Rest and work* — Animals digest their food to practically the same extent whether at rest or work.

2. *Digestibility as affected by conditions pertaining to the fodder.*

(*a*) *Quantity of fodder* — The extent to which a coarse fodder is digested by our domestic animals is not affected by the quantity consumed. It is as perfectly digested when the animal eats all it will take as when it consumes but a small quantity.

(*b*) *Effect of drying* — The digestibility of coarse fodders is not decreased by drying if all other conditions remain the same. In ordinary hay making a considerable portion of the leaves and most tender parts is not infrequently broken off and lost. The least valuable portions remain and hence hay is ordinarily less digestible than grass ; but if hay can be made without the losses alluded to it is equally as digestible as grass. Exposure to rain during curing decreases the value of fodders. A portion of the more soluble nutrients, such as sugar, is washed out.

(*c*) *Long keeping* — When dry fodder is stored for a long time, even under the best conditions, it loses both in palatability and digestibility, owing to gradual changes which take place.

(*d*) *Stage of growth* — In most instances the digestibility of forage crops lessens as growth advances. We have to consider, in deciding when the fodder crop should be harvested, total quantity of digestible nutrients as well as digestibility. The total quantity is usually greatest when the crop is harvested at about the time of full bloom.

(*e*) *Method of preparing* — Moistening, steaming, or warming may sometimes be accompanied by practical advantages, but preparation of food in any of these ways does not increase its digestibility. The gain, if there be one, is simply due to increased palatability. Cutting or chaffing may help somewhat. The more palatable food is made the better are its effects.

(*f*) *Concentrated food added to coarse fodders.*

"1. A feed rich in easily digestible protein does not affect the digestibility of the coarse fodder.

"2. Fat. Small quantities of fat seem to increase digestibility. More than ten ounces a day for a cow of ordinary size depresses digestibility.

If not fed by itself, but as oil cake or meal, more than this may be fed without causing such depression.

"3. Carbohydrates. Additions of starch, sugars, etc., until they amount to 10 per cent. or more of the dry substances of a ration, depress the digestibility, particularly of the protein and fiber. If nutritive ratios (717) exceed 1 : 8 some of the carbohydrates are similarly affected." *

(*g*) *Roots and potatoes* — If the dry substance of these makes up more than 15 per cent. of that of the entire ration, digestibility is decreased ; otherwise it is not affected. If fed with concentrated food rich in protein, more than 15 per cent. of the dry matter of the entire ration may be derived from roots or potatoes without lessening the digestibility.

(*h*) *The effect of common salt* — It is well known that a certain amount of common salt is essential to animal life, and a liberal amount is quite generally believed to be beneficial. Whether this is the case cannot be considered as fully established. It does, however, appear to be certain that such benefit as may follow from a liberal use of salt cannot be due to a favorable effect upon the digestion of fodders. Indeed, such experiments as have been tried indicate that when salt is largely given in connection with foods their digestibility is somewhat decreased.

(*i*) *In general* — Grains and by-products from grains and from oil seeds are in general more digestible than coarse fodders ; immature fodders more digestible than mature ; and ground feeds more than those which are not ground.

715. *Digestion coefficients* — A digestion coefficient is a number which expresses the percentage of a nutrient in a given food stuff which is regarded as digestible. It has been stated that as found in ordinary food stuffs nutrients are not entirely digestible, and further that the extent to which the different nutrients are digested varies. The degree to which the nutrients in food stuffs are digested is determined by experiment ; and most of the experiments from which such information as we possess has been derived have been tried with animals. Methods of artificial digestion experiments have been tried, but they are not on the whole as satisfactory as those where

* Bulletin 81, Vermont Experiment Station.

the food in question is actually fed to animals. The digestion coefficient for protein in different food stuffs ranges from 6 to 94 per cent.; for nitrogen-free extract, from 29 to 100 per cent.; for ether extract, from 19 to 100 per cent. In order to determine how much of any given nutrient in a food stuff is digestible, the total amount of such nutrient present in the fodder must be multiplied by the digestion coefficient. The product is the number of pounds of the nutrient in 100 pounds which is digested. To make this clear let us take as an example Buffalo gluten feed.

BUFFALO GLUTEN FEED.

	Crude Protein.	Crude Fiber.	Nitrogen-Free Extract.	Ether Extract.
Amount of nutrients in 100 pounds....	27.1 lbs.	6.7 lbs.	51.1 lbs.	3.3 lbs.
Digestion coefficients................	.86	.78	.89	.84
Digestible nutrients..................	23.3 lbs.	5.2 lbs.	45.5 lbs.	2.7 lbs.

It will be understood that the figures in the last line are obtained by multiplying the figure representing the total amount of the respective nutrients by the respective digestion coefficients. For the convenience of those desiring to feed their cattle in accordance with the principles of science, such calculations as that which has just been illustrated have been made by many different experiment station workers and writers. It is entirely unnecessary that each farmer should make these calculations for himself. It is far better that they be made with the utmost care and accuracy by a person accustomed to such work and that the results be placed in the farmer's hands. True, the digestibility of different nutrients varies according to different conditions, and some knowledge of the extent of the variation and the conditions likely to cause it must be of value to the intelligent student of feeding. But for the busy, practical man the use of average figures answers fairly well. Accordingly in the tables which accompany this volume, by the use of which the feeder must make all necessary calculations, figures showing composition and amount of digestible nutrients only are given; and to still further simplify matters for the farmer, the amounts of digestible nutrients in varying quantities of the different food stuffs which are most commonly used

are also published in what is called by its author, Professor Hills, Director of the Vermont Experiment Station, "a convenience table." These tables will be found in the Appendix to this volume. The method of using the convenience table will be fully explained and illustrated. It will be found that it makes the matter of feeding in accordance with scientific principles comparatively easy.

716. *Classes of foods* — For the sake of brevity modern writers on the subject of feeding use two terms which have been comparatively recently coined, viz., roughage and concentrate. The term roughage includes all of the comparatively coarse and bulky food stuffs : straw, hay, silage, green fodders, grass. The term concentrate includes all those food stuffs which in comparatively small bulk furnish a large amount of nutrients, such as grains and by-products of grains, etc. ; as, for example, corn meal, gluten meal, cottonseed meal, etc.

717. *Nutritive ratio* — The term nutritive ratio designates the ratio or relation which exists between the total digestible nitrogen-containing constituents of a food (crude protein) and the total digestible non-nitrogenous constituents. This relation is expressed in arithmetical terms, and for convenience it is customary to consider the digestible protein as 1. Thus, for example, if there be 3 pounds of digestible protein and 15 pounds of digestible carbohydrates and fat, the nutritive ratio is determined by the common rules of proportion : viz., 3 : 15 : : 1 : 5. This statement that the nutritive ratio of a given food or a combination of feeds is 1 : 5 means simply that it contains 5 times as great a quantity of digestible carbohydrates and fat as of digestible protein. In determining nutritive ratios the digestible fat is always combined with digestible carbohydrates, for the reason that fat and carbohydrates serve essentially the same functions in the body (712); but while they serve the same functions they have not the same unit value. The most important of the functions served by these nutrients is the production of heat. A given quantity of fat has from 2.25 to 2.5 times the value for heat production possessed by an equal quantity of carbohydrates. It is necessary, therefore, in calculating nutritive ratios to multiply the weight of the fat by some factor before the fat can be combined with the carbohydrates, and in all calculations which will be later given the factor selected is

2.25. This factor has been used in calculating Table III, Appendix (Convenience Table).

Nutritive ratios are spoken of as wide, medium, or narrow. A wide nutritive ratio is one in which the carbohydrates greatly exceed the protein. A narrow nutritive ratio is one which contains a relatively small amount of carbohydrates. All kinds of straw have a very wide nutritive ratio, about 1 : 30 or 40. Cottonseed meal has a very narrow ratio, about 1 : 1.

To make the method of calculating the nutritive ratio clear, two examples will be given, — Buffalo gluten feed and turnips.

From Table II, Appendix, we find that Buffalo gluten feed contains the following amounts of digestible nutrients: protein, 23.3 per cent.; crude fiber, 5.22 per cent.; nitrogen-free extract, 45.5 per cent.; ether extract (crude fat), 2.7 per cent. Multiply 2.7 by 2.25 to convert the crude fiber into the equivalent amount of carbohydrates. The product is 6.08. Then add to this the amount of digestible crude fiber and digestible nitrogen-free extract, viz.: $6.08+5.22+45.5=56.8$. This is the total amount of carbohydrates. The nutritive ratio is determined by the proportion $23.3 : 56.8 :: 1 : 2.4$. It will be noticed that in finding the second term of the ratio practically all that is done is to divide the sum of all the carbohydrates (and fat converted into carbohydrates) by the protein, and this method of determining the second term of the second ratio will be hereafter used.

Buffalo gluten meal has what is called a narrow ratio.

Turning again to the table we find the percentages of digestible nutrients in turnips to be: protein, 1; crude fiber, 1.2; nitrogen-free extract, 6; ether extract (crude fat), 0.2. Making the calculation as before: —

$$0.2 \times 2.25=0.45.$$
$$0.45+1.2+6=7.65.$$
$$7.65 \times 1.0=7.65.$$

In figuring nutritive ratios it is not customary to carry the calculation beyond one place of decimals. The nutritive ratio of turnips, therefore, would be said to be 1 : 7.6, which is a moderately wide ratio.

A thorough understanding of what the term nutritive ratio means and of the method of computing it is of much importance. As has been pointed

out (711), protein in the food serves functions entirely distinct from those served by the other nutrients, and one of the most important points in connection with feeding is to use such kinds and quantities of food as will furnish nitrogenous and non-nitrogenous nutrients in the proper relative amounts.

718. *What the word ration signifies* — The word ration is used to signify the kinds and quantities of foods provided for a given length of time. The most common unit of time used in connection with the statement of a ration is a single day ; for example, a cow is to receive daily : —

Silage,	35 pounds.
Clover hay,	12½ "
Wheat bran,	4 "
Cottonseed meal,	3 "
Cleveland linseed meal,	1 "

This statement of kinds and amounts of foods is a statement of the daily ration of the cow.

719. *Calories* — It is believed that the amount of heat produced when the digestible part of a food is burned affords a correct indication as to its food value. Accordingly what may be called a food yard stick has been adopted. This is the calorie. As an inch is a line of certain definite length, so a calorie is a definite amount of heat. It is the amount which is required to raise the temperature of a pound of water about 4° F. As a yard stick would be useful in determining the relative length, and therefore the relative value, of a number of pieces of cloth, so the calorie is of value as a means of measuring the relative food value of different kinds and combinations of foods. The number of calories in any given amount of food can be obtained by multiplying the number of pounds of digestible protein by 1,860, the number of pounds of digestible carbohydrates by the same number, the number of pounds of digestible fat by 4,220 and adding these products. In the opinion of some writers on feeding, the calorie should be used as a means of determining whether a given combination of fodders and feeds is sufficient for the needs of the animal to be fed. It has not, however, as yet been generally adopted and will not be further spoken of.

CXVII — FEEDING STANDARDS.

720. *What a feeding standard is* — A feeding standard is a statement of the amounts of total dry matter and of digestible nutrients required by an animal for a given length of time. The most common unit of time is one day. Feeding standards are not arbitrarily fixed. They express the conclusions of careful scientific men based upon extended experiment and observation. They indicate what amounts of the different nutrients in the opinion of such men are daily required by the animal for which the standard is established. The feeding standards in existence are not supposed to be absolutely perfect. They are subject to change. They may be modified as the result of further investigation, but they express the best knowledge of the present time. It is not to be supposed that all animals of the same class, even, are precisely alike in their requirements. One may be capable of making profitable use of a larger amount of nutrients than others. The standard is not, then, to be blindly followed. It is, however, the best guide to economic feeding within our reach at the present time, and feeding in accordance with a standard is likely to give far better economic results than feeding without any such guide. Several different feeding standards for the different classes of farm animals have been published. Perhaps the one which has been more commonly used than any other in this country is the Wolff standard for the milch cow, which is as follows: —

A cow weighing 1,000 pounds, requires daily in her food:

Total dry matter,	24 pounds.
Protein,	2.5 "
Carbohydrates,	12.5 "
Fat,	0.4 "

The nutritive ratio by this standard is 1:5.4.

This statement means that in the opinion of its author a cow weighing 1,000 pounds (which is above the average size where Jersey blood predominates) should receive daily foods sufficient to furnish the quantities of the several nutrients named. These are the quantities which, in the opinion of the author of this standard, would be calculated to cause the cow to give

the largest quantity of milk of which she was capable. A standard of this kind Hills speaks of as a physiological standard, and he calls attention to the fact that it does not take into account at all the possible question of profit and loss. What he means may be illustrated as follows: —

If, in a given locality, foods which furnish a large proportion of protein should be exceptionally cheap, while those furnishing a large amount of starch and sugar (carbohydrates) should be unusually high, it might be more profitable for the farmer to give a cow relatively more protein and less carbohydrates. A standard, as modified by consideration of the cost of the several nutrients in different foods, as Hills states, must usually be homemade. Prices vary from year to year and in different localities so widely that it is impossible for the scientific man to publish a standard which will permanently satisfy the economic requirements. A standard which does this Hills calls a practical standard. Some of our experiment station officers have been at great pains to ascertain what good farmers in their respective localities were in the habit of feeding: they have then from their knowledge of the composition of the different foods used, calculated the quantity of the several nutrients supplied in these farmers' rations. They have then averaged the results of a large number of such rations and these they have published as average feeding standards. Table I, Appendix, gives feeding standards for the different classes of domestic animals. Among these standards the Wolff-Lehman standards and the Connecticut (Storrs) standards are what may be called physiological standards; while the Wisconsin is what may be called an average standard.

721. *Should the farmer attempt to feed by a standard?* — To the farmer who has never studied this matter it will naturally seem that it must be very difficult to feed in accordance with a standard, and such a farmer will naturally ask why it is not sufficient for the scientific man to study the matter out and then to give explicit advice, calling, for example, for certain amounts of hay of given quality, silage, wheat bran, and cottonseed meal. Such advice, though easily followed, would have but a limited application, for only when the farmer happened to possess or found it practicable to purchase the right quantities of the feeds mentioned would he be able to use the sug-

gestions made. Knowing how much of the several nutrients is called for, it is a simple matter, whatever the food stuffs available, to make up a ration which will furnish the needed quantities.

722. *What standard should be used?* — The farmer may be in doubt which among the several standards which are included in the table it will be best for him to use. This is not a matter upon which very definite advice can be given. The choice of a standard may vary from time to time in accordance with the prices of different food stuffs, as well as in accordance with the prices obtained for animals and animal products. The feeder must use his judgment upon this matter. It is believed, however, that under the conditions existing in most of the Northeastern states the Wolff-Lehman or the Connecticut (Storrs) standards will be found best. Farther West where corn, which is rich in carbohydrates, is very abundant and cheap, the farmers as a rule feed relatively less protein. This is indicated by the Wisconsin standard, which is the average of the feeding practice in 132 herds. The course followed by these Western farmers may doubtless be better suited to their conditions than would be a closer adherence to the Wolff-Lehman standard, but at the prices prevailing for starchy feeds such as corn in most parts of the New England states, the adoption of the Wisconsin standard would probably not give as profitable results as can be obtained by following a standard supplying more protein.

723. *Figuring a ration* — The method to be followed in figuring a ration will be best understood by taking an example. It will be seen that it is essentially at the start guessing and then making the necessary calculations to see how close the guess is to the standard. With experience as a guide one soon learns to make guesses very nearly right at the start, but at first one may have to change the amounts of the different foods selected again and again before he will finally secure the several nutrients in the right amounts and proportions. In figuring a ration it will as a rule be found best to fix first upon the amounts of the several roughages and the concentrates containing relatively small amounts of protein, leaving the determination of the amount of the food highest in protein until last. This is the case because a comparatively slight variation in the amount of such

feeds will affect the closeness of the ration to the required standard in very marked degree. In figuring rations the convenience table found in the appendix should be used.

Let us suppose that the farmer has corn silage made from fairly mature corn, and red clover hay, and that he can purchase wheat bran, cottonseed meal or linseed meal. Let us calculate a ration which will satisfy the requirements of the Wolff-Lehman standard for a cow giving about 30 pounds of milk a day, and having a live weight of 1000 pounds. Turning to the convenience table,* find mature corn silage, red clover hay, and wheat bran. Let us take to start with 30 pounds of silage, 12.5 pounds of clover hay, and 4 pounds wheat bran, The amounts of total dry matter and digestible protein and carbohydrates are readily read from the tables. The calculation will be as shown below : —

	Dry Matter. Pounds.	Protein. Pounds.	Carbohydrates. Pounds.
Corn silage, 30 pounds	7.9	0.36	5.3
Red clover hay, 12.5 pounds	10.6	0.89	5.2
Wheat bran, 4 pounds	3.5	0.48	1.8
Totals	22.0	1.73	12.3
Wolff-Lehman standard	32.0	3.3	14.77

Comparison shows a deficiency in the several constituents as follows : dry matter, 10 pounds ; protein, 1.57 pounds ; carbohydrates, 2.47 pounds. It will be noticed that there is a relatively large deficiency in the amount of dry matter and in protein. The food stuff which contains the highest percentage of protein is cottonseed meal. Let us try 3 pounds of cottonseed meal, the amount of nutrients in which may be found in convenience table.*

	Dry Matter. Pounds.	Protein. Pounds.	Carbohydrates. Pounds.
In foods already selected	22.0	1.73	12.3
Cottonseed meal, 3 pounds	2.8	1.2	1.2
Totals	24.8	2.93	13.5

* See Appendix.

We are nearer the required amount of protein but there is still a shortage of about .4 pounds. Three pounds of cottonseed meal, however, is about as much of this food as it is ever safe to give, so that to make up the balance of the protein needed it will be wiser to select some other food rich in that constituent. Let us take 1 pound of linseed meal (N. P.), the digestible nutrients in which will be found in convenience table.* The calculation now stands :—

	Dry Matter. Pounds.	Protein. Pounds.	Carbohydrates. Pounds.
Total in foods already selected	24.8	2.93	13.5
Linseed meal (N. P.), 1 pound	0.9	0.32	0.4
Totals	25.7	3.25	13.9

We have now nearly the required amount of protein but are considerably short in carbohydrates and in dry matter. Let us, therefore, see what will be the result of adding more of the food which is highest in carbohydrates, viz., corn silage. Let us take 5 pounds of this. Our calculation will then stand : —

	Dry Matter. Pounds.	Protein. Pounds.	Carbohydrates. Pounds.
Foods already selected	25.7	3.25	13.9
Corn silage, 5 pounds	1.3	0.06	0.8
Totals	27.0	3.31	14.7

We are now almost exactly like the standard in protein and in carbohydrates but have less dry matter. This, however, is not important. While a certain amount of dry matter is essential in order to give sufficient bulk to the food, there can be no doubt that the ration which we have calculated will satisfy this requirement. In Europe, where the Wolff-Lehman standard was established, it is customary to feed straw to a considerable extent and this adds relatively more to dry matter than to digestible nutrients. Straw might be added to our ration but it is more than doubtful whether a cow fed such a ration would consume straw, so we may regard the ration thus calcu-

*See Appendix.

lated as satisfying the requirements of the standard sufficiently well for all practical purposes. Indeed, there can be little doubt that a ration furnishing the required nutrients in 27 rather than in 32 pounds of dry matter will be the better of the two. Our completed ration, daily, then, for a cow weighing 1000 pounds, will stand as follows : —

	Dry Matter. Pounds.	Protein. Pounds.	Carbohydrates. Pounds.
Corn silage (mature), 35 pounds	9.2	0.42	6.1
Red clover hay, 12.5 pounds	10.6	0.89	5.2
Wheat bran, 4 pounds	3.5	0.48	1.8
Cottonseed meal, 3 pounds	2.8	1.20	1.2
Linseed meal (N. P.), 1 pound	0.9	0.32	0.4
Totals	27.0	3.31	14.7

The nutritive ratio is 1 : 4.47. This is a very narrow ratio and only cows giving a large product and having vigorous digestion will be found capable of making profitable use of so much food. Such a ration should be approached gradually and the feeder should be watchful for signs of derangement of digestion. With loss of appetite or failure to relish food, the quantity of the cottonseed meal should be somewhat reduced.

To still further illustrate the calculation of a ration let us take another example. Let us suppose that the farmer desires to feed rather more silage, and that in place of cottonseed and linseed meals he prefers to feed gluten meal. Let our first trial be as shown below : —

	Dry Matter. Pounds.	Protein. Pounds.	Carbohydrates. Pounds.
Corn silage (mature), 40 pounds	10.5	0.48	7.1
Clover hay, 10 pounds	8.5	0.71	4.2
Wheat bran, 3 pounds	2.6	0.36	1.4
Totals	21.6	1.55	12.7
Standard	32.0	3.3	14.77

Our ration is short : dry matter, 10.4 pounds, protein, 1.75 pounds, carbohydrates, 2.07 pounds. We find in this case, as in the first, that the constituents which are relatively most lacking are protein and dry matter.

Consulting convenience table,* we find that 5.5 pounds Chicago gluten meal will give us almost exactly the required amounts of protein and carbohydrates. With this addition the completed ration is as follows :—

	Dry Matter. Pounds.	Protein. Pounds.	Carbohydrates. Pounds.
Corn silage (mature), 40 pounds	10.5	0.48	7.1
Clover hay, 10 pounds	8.5	0.71	4.2
Wheat bran, 3 pounds	2.6	0.36	1.4
Chicago gluten meal, 5 pounds	4.8	1.76	2.5
Totals	26.4	3.31	15.2

The nutritive ratio in this ration is 1:4.5. This like the other ration is short in dry matter, but, as has been pointed out, this is not important. It must be regarded as a sufficiently close approximation to the standard. In deciding upon the relative economy of different feeding stuffs, the manurial value must be taken into account. It will be remembered that about 80 per cent. of these should be recovered in the excrements of milch cows (303). For manurial values of foods, see Table IV, Appendix.

724. *Is it to be expected that the farmer will weigh out foods for each animal in the herd?* — The answer to this question is, most decidedly no. This would be altogether too much trouble. Standards in the first place are not infallible. Animals should be fed, in a measure, in accordance with the judgment of a careful feeder. The standard is based upon live weight. Strictly speaking it must be concluded that each cow should receive an amount above or below the amounts figured for the 1,000-pound cow in proportion as she exceeds or falls below the weight of 1,000 pounds. While the live weight of the animal is perhaps as good a general basis as can be formulated for determining the amount of food animals need, it is well known to all practical men that the food which animals can profitably consume is by no means always exactly proportional to the weight. Here, again, the judgment of a careful and observant man will lead him to vary the quantities of the several foods somewhat in accordance with the individual peculiarities of the animals in the herd. What, then, it may be

*See Appendix.

said, is the use of a standard if it is not to be lived up to? In the writer's opinion it should be used and will prove exceedingly helpful in the following way: Determine as closely as possible the live weight * of all the animals in the herd which is being fed, and for a few days weigh out the coarse fodders in such quantities as are needed for the entire herd. If, for example, there are ten cows whose aggregate live weight is 9,000 pounds, then there will be needed of the coarse fodders 9 times the quantities figured in the ration. Or, if the animals are fed silage, let us say twice daily, weigh out a few times the quantity needed for the morning and for the evening feed by itself. In dividing this among the cows, use a basket and determine by a few trials about the quantity which the basket holds. In this manner silage can be divided among the different cows with sufficient accuracy. The hay, perhaps, may well be fed one-half at noon and the balance at night. If this is the practice, then half the total amount may be weighed out a few times and divided among the ten cows, in part in accordance with their weight and in part in accordance with judgment. For the grains it suffices to make a mixture containing the different grains which are to be used in the same proportions as are called for by the ration. In the case of the last ration figured, for instance, mix together 300 pounds of wheat bran and 550 of Chicago gluten meal; or greater amounts in the same proportion if preferred. The grain will probably be fed in about equal quantities morning and night. For the purpose of dividing it, use a rather deep, cylindrical tin measure and before beginning to use it weigh out in it the required weight of the mixture. In the case of the last ration figured, if this is to be given in two equal feeds, the quantity required is 4¼ pounds to a feed. Make a prominent mark on the measure at the point where the grain mixture stands when the measure contains 4¼ pounds. With such a measure, filling a little above or a little below this mark, in accordance with the size of the cow or in accordance with judgment as to her requirements,

* Whitcher has given a rule for calculating the approximate live weight of cows, which is as follows:—

"Ordinary cattle girting 5 feet will weigh 650 to 700 pounds, according to form and fatness; for each additional inch in girth add 25 pounds up to 6 feet, and for each inch after 6 feet add 50 pounds."

the grain feed can be divided with sufficient accuracy. If desired, of course, different weights of the grain mixture may be successively taken and the different points prominently marked as for the standard quantity of 4¼ pounds. When the hay and silage have been weighed out a few times as suggested, the farmer will be able to judge, as to the quantities of these needed, with sufficient accuracy by eye (and measure in case of the silage) as described. In the case of coarse fodders, moreover, it is entirely safe to feed these to animals in as large quantities as they will consume. By acting upon such suggestions as have been made the farmer will find that it is not very much trouble to feed practically in accordance with a standard. The calculation of a standard will take but a short time and the results of using it as a guide to the judgment will amply compensate for the extra trouble.

CXVIII — CATTLE FOODS.

725. *General considerations and classification* — The number of materials available for cattle foods has increased in marked degree within the past twenty-five or thirty years. This increase has been due in part to the introduction of new crops, in part to new manufacturing processes. In Volume II, much information has been given in connection with the various farm crops as to their composition and value in stock feeding. It is unnecessary in this connection, therefore, to consider at much length such crops used for feeding farm animals as are usually produced on the farms in the older states. It is important, however, to consider briefly the general nature and value especially of such foods as are usually purchased. The food stuffs of vegetable origin may be included under four classes : —

1st. Forage crops, which include stems and leaves, and sometimes seeds (either partially formed or wholly mature), either green or dry.

2d. Roots and tubers.

3d. Seeds and grains.

4th. By-products, which include parts of seeds or grains left after removing other parts by some manufacturing process.

726. *Forage crops* — Practically all forage crops of proved value in the Northeastern states belong to two families of plants, grasses and

legumes. These are the most valuable classes of plants whether in pastures, mowings, or tilled fields. The chief difference in nutritive value in forage crops belonging to these two families is the larger proportion of protein in the legumes. As protein is of great importance in connection with milk production, the legumes should occupy a prominent position on dairy farms. The following from Bulletin 77, Rhode Island Experiment Station, makes this matter very clear.

"Below are given two rations which are exactly alike except that one contains ordinary mixed hay with little or no clover, and the other clover hay. It is particularly interesting to notice the influence of clover hay in raising the absolute amount of digestible protein and in narrowing the nutritive ratio. It will be seen from this why the man who grows large amounts of clover needs to buy less grain than his neighbor who ignores the virtues of clover. If Rhode Island farmers will lime their land and manure generously with potash and phosphoric acid, they can grow good clover even with little or no nitrogen, since the plants can draw nitrogen from the air. Clover is one of the important keys to successful dairying in Rhode Island.

RATIONS FOR 900-POUND COWS.

Ration with Ordinary Hay.		*Ration with Clover Hay.*	
3.0 pounds	corn meal.	3.0 pounds	corn meal.
2.5 "	bran.	2.5 "	bran.
1.0 "	cottonseed meal.	1.0 "	cottonseed meal.
15.0 "	mixed hay (ordinary).	15.0 "	clover hay.
7.5 "	corn stover.	7.5 "	corn stover.
The ration contains: —		*The ration contains:* —	
22.90 pounds	dry matter.	22.80 pounds	dry matter.
1.66 "	protein.	2.08 "	protein.
12.80 "	carbohydrates and fat.	12.50 "	carbohydrates and fat.
Nutritive ratio, 1:7.8.		Nutritive ratio, 1:6.0.	

"It will be seen that with the mixed hay ration only 1.66 pounds of digestible protein were furnished, but with the one containing clover hay there were 2.08 pounds. The latter had a nutritive ratio of 1 : 6 as against 1 : 7.8 where the clover was replaced by the ordinary mixed hay. This means that, with the use of clover hay, less of the very expensive nitrogenous

feeding stuffs are required than where it is replaced by mixed hay, corn stover, corn fodder, corn silage, and most of the kinds of roughage grown in Rhode Island."

What the writer says is true of Rhode Island in this respect is almost equally true of many sections in the older states. Clover, alfalfa in districts where it thrives, and other legumes should be much more grown than is the case on dairy farms.

It has been pointed out that there is not much difference between the digestibility of forage crops, whether green or dry, providing they have been dried under perfect conditions. Such drying, however, as is well understood, is seldom possible. Practically speaking there is always some loss in connection with drying. Moreover, and this is important, the green fodder is usually more palatable than the dry. In considering hay making (519), it has been pointed out that grasses and legumes valuable as hay crops should in general be cut when in bloom. The total yield, it is true, usually increases up to about the time of full ripeness, but in case of the ordinary field grasses the plant becomes much harder in texture and less palatable. It is undoubtedly also less digestible. The proportion of crude fiber increases up to the period of ripeness, while the percentage of protein decreases from the time when the plant is well headed out until it is nearly ripe. As a result of digestion experiments with timothy hay, Jordan states that it is shown that the total yield of digestible matter from one acre when the plant was cut in full bloom was 2,306 pounds; when cut when out of bloom or nearly ripe, 2,350 pounds. The amounts are practically the same but timothy cut when nearly ripe is far less palatable, so that the advantage is clearly with the earlier cutting. What is true of timothy appears to be almost equally true of clovers, but the loss of parts through shedding of leaves and crumbling is much greater if cutting is deferred much beyond the period of bloom. It must at once be seen that clovers as well as grasses should be cut early.

The facts are quite different as regards Indian corn. This plant as it matures continues to gain not only in total weight of dry matter but in quality. True, the proportion of protein is less in mature than in immature

corn, but the carbohydrates (starch and sugar) and the fat continue to increase almost to maturity. The total yields of dry matter per acre at different stages of growth, as determined by two of our experiment stations, are shown below : —

STAGE OF GROWTH.	New York. 1899. Pounds.	Maine. 1893. Pounds.
Tasseled to beginning of ear	1,620	3,064
Silked to some roasting ears	3,080	5,211
Watery kernels to full roasting period	4,640	6,060
Ears glazing	7,200	6,681
Glazed to ripe	7,920	7,040

Digestion experiments in the United States show that of the total dry matter yielded by the corn crop 65.7 per cent. was digestible when cut before glazing ; 70.7 per cent. when cut after glazing. When the crops were put into the silo the averages were : before glazing, 67.4 ; after glazing, 73.6 per cent.* It will be seen, therefore, that the corn plant should be allowed to become nearly mature before it is harvested and this is true whether it is to be fed green, cured, or made into silage.

CXIX — SILAGE.

727. *Silage a comparatively new fodder in the United States* — It is only about twenty-five years since the first experiments in making silage in the United States were made. This food had been known and used in Europe for some little time. Silage is the name applied to a green fodder preserved in the silo. The process of preserving green fodder in a silo is known as ensilage. The fodder itself is also frequently spoken of as ensilage, but it seems desirable for the sake of brevity and accuracy that the first syllable should be dropped. We need two words, one to designate the process, the other to designate the fodder. Still another word, ensiled, meaning put into the silo for the purpose of preservation, though not generally used, is convenient and will be here employed.

* Jordan, "Feeding Animals."

728. *Crops for ensilage*—The number of crops that have been successfully ensiled in the United States is not very large. Indian corn is much the most valuable. Legumes as a rule do not keep well in the silo, though they can be preserved if put in in a mixture with crops containing less protein. Clover and field peas, which should generally be allowed to wilt somewhat before being put in, have been ensiled with a fair degree of success. It will not as a rule be expedient to ensile the true grasses or cereal grains or millets. These in our climate can usually be easily dried.

Crops with hollow stems, since these contain confined air, do not as a rule keep as well as those with solid stalks like corn. Moreover such crops as those last named can commonly be preserved with less waste by drying than by ensilage.

729. *Silage less valuable for food than the green fodder from which it is made* — Many wild statements have been made concerning the results of ensilage. Not a few of the earlier writers on the subject claim that as the result of this process the feeding value of crops is increased. This is not the case. Silage, it is true, may be more valuable than would be the same fodder dried, but it cannot possibly be of greater value than the fodder put in. There is always some loss of food value in ensilage. This is due primarily to the fact that the fodder heats and ferments to a certain extent. As a result of the fermentation, certain of the nutrients which are contained in the green fodder are changed into other and less valuable compounds. They may, indeed, be changed into compounds such as acids, which have no food value.

730. *Nature of the changes in the silo* — The changes which go on in the silo are very complex. As a rule some alcohol, and acetic, lactic, and other acids are formed. Whether these substances are formed as the result of the activities of living ferments or whether they are due to other causes is not definitely known. This point, however, is not of direct interest to the practical man. It is important, however, that he should know that, as a result of the changes which go on in the silo, the silage contains considerably less dry substances than the original green fodder. In a certain sense we may say that as the fodder heats in the silo some portion of its constit-

uents are actually burned. Green corn fodder is rich in sugar. Silage made from such fodder contains much less sugar, sometimes none at all. The acids which make silage sour are undoubtedly formed chiefly from the sugars of the original material. Sugar is a valuable food. Acids have no food value if they be not actually harmful. The amount of dry matter destroyed and the extent to which sugar is converted into acids depend in part upon the kind of fodder and in part upon the care with which the silo is built and filled. Another undesirable change which goes on in ensilage is the conversion of the more valuable protein compounds into the less valuable amides. Experiments in the Pennsylvania Station indicate that in some cases fully one-half of the nitrogen in the silage exists in amide form. This is at least two or three times as large a proportion as was found in the fresh fodder. Undoubtedly the chief loss in food value in making silage is due to the destruction of sugar. Starch is much less affected than sugar by the changes which go on in the silo, and this, without doubt, is one reason why silage made from corn which is very mature contains less acid than that from immature corn. As corn matures the starch increases rapidly, while the percentage of sugar decreases in the final stages of ripening. This is evident from the results of an experiment conducted at the Maine Experiment Station.

IN 100 PARTS DRY MATTER OF CORN.

Stage of Growth.	Sugar.	Starch.
Very immature	11.7	....
A few roasting ears	20.4	2.1
All roasting ears	20.6	4.9
Some ears glazing	21.1	5.3
All ears glazed	16.5	15.4

How important it must be to allow corn to become quite mature before ensiling it, is made sufficiently evident in view of these facts.

731. *The amount of loss in the silo* — The amount of loss of food value which may take place in the silo may be small under the best management. King put 64.7 tons of silage into a silo lined with galvanized iron which was made perfectly air-tight. He found that it lost an average of 6.38 per

cent. of dry matter. This silage was put in in eight separate layers and the proportion of loss in each layer was determined and was as follows : —

Surface layer	8,934 pounds,	lost 32.53	per cent.	dry matter.
Seventh layer	8,722 "	" 23.38	"	"
Sixth layer	14,661 "	" 10.25	"	"
Fifth layer	48,801 "	" 2.10	"	"
Fourth layer	13,347 "	" 7.01	"	"
Third layer	7,723 "	" 2.75	"	"
Second layer	12,689 "	" 3.53	"	"
Bottom layer	12,619 "	" 9.47	"	"

These facts make it perfectly evident that the loss is largely confined to the surface portion. This is undoubtedly due to the fact that here the material is not as solidly packed, more air is retained in the mass, and it is, moreover, exposed at the surface to the outer air. The importance of so managing as to keep the loss at the lowest possible point is self-evident. It must be remembered that this loss affects chiefly the sugars, which are among the most valuable constituents of corn fodder.

732. *Ensiling versus field curing* — It has been pointed out (516, *a*) that, in one of the most careful experiments carried out in this country to determine whether it is better economy to ensile a corn crop or to cure it, the advantage was found to be most decidedly in favor of ensilage.

Jordan summarizes the results of other experiments bearing upon this question as follows : —

"A general survey of the data accumulated shows that on the whole the waste has been the larger in the field curing. Observations made in six states reveal a loss by the old method as low as 18 per cent. in only one case, and from 21 per cent. to 34 per cent. in all others. Possibly, under favorable conditions of weather, field cured corn fodder may lose as little dry matter as silage, though this is doubtful, but in bad weather the waste from the exposed fodder is extensive. The greatest advantage in silo preservation is that conditions can usually be controlled with more satisfactory average results than are possible in field curing. Other advantages pertain to the silo which are of a business nature and which need not be discussed

here, further than to affirm that cost of a unit of food value is in general diminished by the use of the silo."

733. *Construction of silos* — The essentials in a good silo are that it shall be air-tight, that the walls shall be perfectly vertical, strong enough to resist lateral pressure, and that the depth shall considerably exceed the horizontal dimensions. Silos which fulfill these conditions are best because the air is excluded as nearly as possible, the material packs closely, and there is comparatively little surface exposed to the air. Silos may be either round, square, or rectangular. Where the silo is built in the barn farmers usually prefer to make them either square or rectangular, because this form secures better economy of space. If one of these forms is selected the nearer it is to a square the better, all things considered. Where the silo is built outside the barn, the round form in the opinion of many is best. Less lumber is required in proportion to capacity and it is far easier to secure the necessary strength. Moreover, the fodder usually settles better in the round silo. If a square or rectangular silo is built the corners should be cut off inside by setting up a plank which should be about a foot in width. This is desirable both because it will be difficult, otherwise, to keep the air from entering the silo at the corners, and because the fodder settles much better. Silos have been built of a number of different kinds of material — wood, brick, stone, and concrete. On the whole wood is found most generally satisfactory. Whatever the material the silo should be so made as to be as nearly air-tight as possible, and the inside surface must be smooth so as to allow even and uniform settling. Various lining materials have been tried in wooden silos but on the whole with unsatisfactory results. It is quite generally believed, however, that painting the inner surface of the silo with some preservative will be found to pay. Among such preservatives coal tar which has been boiled or even ignited to drive off a part of its more volatile constituents has been found quite generally satisfactory. If a wood silo is so constructed that there are dead air spaces between the outer and inner boardings, care should be taken to provide for the circulation of air through these spaces. This will do much to prevent rotting.

734. *The capacity and proper dimensions of silos* — The number of cubic

feet in the silo is obtained by multiplying the area at the bottom by the height or depth. If the silo is square or rectangular multiply together length, breadth, and depth. If round multiply together the square of the radius (distance from the center to the circumference) by 3.142 and this product by the depth. Either of these operations gives us the number of cubic feet. To determine the quantity of silage we must know the weight per cubic foot. This varies to some extent with the fodder, with the horizontal area of the silo, and with its depth. If the silo is small, silage settles less than if it be large, and of course the deeper it is the more solidly it will settle. For ordinary sizes and with depths varying from about 20 to 30 feet, a cubic foot of silage made from mature corn will weigh on the average from about 35 to 40 pounds. While the quantity of silage fed differs widely, it will in a great majority of instances be in the neighborhood of the quantities just named. It will be seen, therefore, that the silo should be large enough to furnish about as many cubic feet of silage as there are cows in the herd, multiplied by the number of days during which it is to be fed. It will be understood that in determining the size of the silo the estimation must be based on the settled silage, which will ordinarily occupy only about two-thirds to three-fourths of the depth. In feeding silage it is now almost universally regarded as best to take the material from the top. When this method is followed, it is, however, essential to remove a certain minimum depth daily in order to prevent loss, for if silage be too long exposed to the air at the top it moulds and spoils. The depth which must be removed daily in order that there may be no loss from this source varies somewhat with the season. It must be greater in summer than in winter. For winter feeding it is believed that there will be no material loss if the amount removed daily is not less than about 1½ inches. This is ⅛ of a foot. If, for example, then, a farmer has a herd of 10 cows and is feeding 35 to 40 pounds daily, he requires 10 cubic feet of silage daily, and if in order to prevent spoiling he must take out silage daily to the depth of ⅛ of a foot, the horizontal surface must be 80 square feet. If the silo is square it must be, therefore, about 9 feet on a side. To ascertain what must be the diameter we must divide 80 by 3.142, which gives a little more than 25, and then

take the square root which gives us 5. This is the radius. The diameter, therefore, will be about 10 feet. Let us suppose that the feeding season is 200 days. For 10 cows then the farmer will need 2,000 cubic feet. If we divide this by the horizontal area, we shall get the depth of settled silage needed. The result is 25 feet. Since the settled silage, however, fills only about two-thirds to three-fourths of the depth, the silo needed must be from about 32 to 36 feet deep. The former depth will be sufficient if the silo is filled slowly or refilled once after settling ; but the latter will be necessary if it is rapidly filled once.

For a guide to determining the proper dimensions of silos for varying numbers of cows consult the table given in the Appendix.

735. *Filling the silo* — The manner in which a silo is filled and the condition of the crop when it is put in have much to do with the quality of the resulting silage. Some of the points bearing upon these questions have already been considered. What follows is, therefore, in part a matter of recapitulation.

(*a*) *The condition of the crop* — Nearly all scientific investigators and practical men agree that corn should be allowed to reach the condition known as glazing before being cut for the silo. Corn which is allowed to reach this stage of maturity will produce silage of fine aroma and containing but little acid ; while silage from the immature, watery corn fodder sometimes ensiled has a rank, disagreeable odor (which may possibly affect the quality of milk and other dairy products if improperly fed and handled), and a large amount of acid.

(*b*) *The preparation of the fodder* — Whether fodder which is to be ensiled should be put in whole, or cut, or shredded depends in part upon its character. Clover can be successfully preserved without cutting, but in the case of corn, while it may be preserved without cutting if packed with the utmost care, covered, and weighted, it is now generally admitted that it is better to cut or shred. This is so because the cut fodder both packs and settles better, more quickly and more uniformly.

(*c*) *The rate of filling* — When ensilage was first practiced, it was the general belief that the silo must be filled with the utmost possible rapidity.

It is now known that this is not necessary. If the silo is filled as rapidly as possible, by the use of a large cutter, the material will afterwards settle to a large extent and the silo space is very poorly utilized. If the silo be filled rather slowly, considerable settling takes place during the process and the result is that a far larger amount of fodder is stored within a given space. Where more than one silo is in use it is desirable to so place them and to so adjust the carrier that food can be put alternately into the different silos. When once the work of filling is begun economic considerations necessitate, in most cases, that it shall be rapidly pushed. No particular harm appears to be done if some two or three days are allowed to elapse between successive fillings. In putting corn which carries a considerable proportion of grain into the silo, much care should be taken to keep the material evenly mixed as well as level. If this is not done it will not settle evenly, and, moreover, if not well mixed, there is danger that in feeding some animals will get an excessive amount of grain while others will have less than the proper allowance.

CXX — STRAWS.

736. *General character and value* — Other cattle feeds are in general so cheap in most parts of the United States that straw is not used as fodder to any considerable extent. Straw of all kinds is comparatively tough, hard, and unpalatable. It is rich in crude fiber, and contains comparatively little of the more valuable nutrients. The most useful straws for feeding purposes are oat straw and legume straws. The latter are especially relished by sheep. Wheat, barley, and rye straws are little used for foods.

CXXI — ROOTS AND TUBERS.

737. *General character and value* — Crops belonging to this class furnish very palatable succulent food which can be kept in perfect condition during the entire winter. They are so highly relished by animals and exert so beneficial an influence upon the general health and condition that their value is not measured solely by the amount of nutrients they contain. The chief disadvantage of these crops is that they are expensive to grow.

The writer has calculated that under conditions prevailing in central Massachusetts 10,000 calories of food when corn is the crop can be produced for a little more than 5 cents ; when mangels are the crop the cost is rather more than 10 cents ; when turnips are grown the cost is about 8 or 9 cents.

CXXII — GRAINS AND SEEDS.

738. *General character and value* — The chief grains used in stock feeding in the United States are Indian corn, oats, barley, and buckwheat. Among these Indian corn is by far the most largely used. All these grains are comparatively rich in starch, fat, and protein. Grains furnish fairly concentrated, very palatable, and highly digestible foods. They are, moreover, in such form that with ordinary precautions they can be preserved indefinitely without loss.

CXXIII — BY-PRODUCTS.

739. *Origin* — A large number of by-products are obtained in the preparation of human foods and of other materials which are of use to man. Many of these by-products are very extensively used in cattle feeding, especially in the dairy sections. In order that the by-product may be suitable for cattle feeding, the process of manufacture must be such as not to injure the palatability or healthfulness. Methods employed in manufacture are constantly changing and as a result by-products are not constant in composition. The farmer must keep posted in regard to the various cattle foods found in the markets in order that he may buy and use them wisely.

740. *Classes of by-products* — The principal by-products used as feeding stuffs have the following origin : —

(*a*) From the milling of wheat and other grains.

(*b*) From the manufacture of oatmeal and other breakfast foods.

(*c*) From the manufacture of beer and other alcoholic drinks.

(*d*) From the manufacture of starch, and sugars, chiefly from corn.

(*e*) From the extraction of oils, chiefly from cottonseed and linseed.

(*a*) *By-products derived from the milling of grains* — By far the most important of the by-products coming under this class are those produced

in the manufacture of flour from wheat. The most important among these are wheat bran and wheat middlings. Both of these consist chiefly of the outer coats of the wheat kernel. These outer coatings of the wheat kernel are much richer in mineral matter, in protein, in crude fiber, and in fat than the interior or starchy portion which enters into the flour. The flour manufacturer does not, however, succeed in effecting complete separation between the starchy interior and the exterior coatings. Both bran and middlings, therefore, contain some starch. Bran is the coarser of the two and ordinarily contains less starch. Middlings contain more of the finer parts of the kernels. Both bran and middlings are subject to considerable variation. Middlings appear to be somewhat superior in average composition to bran, containing about the same amount of protein, somewhat less fiber, and considerably more nitrogen-free extract and fat. Both bran and middlings are among the most valuable and widely used cattle foods.

(*b*) *By-products from breakfast foods* — In the manufacture of breakfast foods which are now so widely used, a number of different by-products are obtained. These are put upon the market as cattle foods. Among the different foods the various grades of oatmeal are most generally used. These can be produced only from the finest grain. In the manufacture of these foods the oats must be first screened for the separation of the largest and heaviest kernels and from these the hulls are removed. These hulls and the smaller grains separated by screening, and, in addition in some cases, bran which is obtained by polishing the hulled grain, are commonly put together, finely ground, and then put upon the market as oat feed. Oat feeds are subject to much variation and they cannot be safely bought without careful previous inquiry as to their quality.

Barley and hominy feeds are other products coming under this class. Barley feed consists chiefly of the hulls with a small proportion of the grain and of course contains more fiber and less starch than the original grain. Hominy feed consists of the skin, the germ, and a portion of the starchy part of the corn kernel. This material is more valuable than the feeds obtained from oats and barley, containing less fiber and being accordingly far more digestible.

(*c*) *By-products from the manufacture of alcoholic beverages* — The most important among the food stuffs included in this class are those produced in the manufacture of beer. Two feeds of considerable value come from this source,— malt sprouts and brewers' grains. The initial step in the preparation of barley for malting is placing the barley under such conditions of moisture and temperature that it will germinate. When the sprout has grown to such length as experience indicates will give the best results, the sprouted grains are dried rapidly, and the sprouts, which are now brittle, broken off by shoveling over the material and then separated by fanning mills. Malt sprouts are perfectly dry and will keep indefinitely. They are not as palatable as some other feeds but are very rich in protein and often sell at a price which makes their purchase expedient. The grain after the separation of the sprouts is ground and crushed and in the process of brewing the sugar produced from the starch during germination is separated. The remnant is known as brewers' grains. It is comparatively rich in protein. Brewers' grains in their natural condition are very wet and will keep but a short time. They can be fed only in the immediate neighborhood of the breweries. At the present time a large proportion of these grains is rapidly dried, after which they can be sent to any distance and will keep indefinitely. They are a perfectly wholesome food and may often be employed with advantage.

(*d*) *By-products from starch and glucose manufacture* — Within comparatively recent times the manufacture of starch and glucose (which is a kind of sugar) from Indian corn has become very extensive and by-products from these manufacturing industries are of much value as feeding stuffs. Among these, gluten meal, gluten feed, and corn bran are among the most important. In the process of manufacture the corn, either before or after soaking in warm water, is crushed into a coarse powder. The hulls float on the surface, the germs sink to the bottom. It is the starch which the manufacturer is after and this remains in suspension in the water. This is slowly conducted through long troughs, where the starch settles to the bottom and the more glutinous portions float off and are finally recovered. Should the hulls be kept by themselves this would constitute corn bran ;

but the bran is now generally mixed with the glutinous portion and ground, when it is put upon the market under the name gluten feed. If the harder and flinty portions of the corn be kept by themselves and ground the product is gluten meal. The hulls and the germs mixed together constitute the product known as starch feed. Sometimes the germs, separated by themselves, are pressed for the extraction of oil. The resulting by-product in this case is known as germ oil meal. All these by-products are valuable feeds though there is much difference between them. Corn bran contains the least protein and most fiber ; gluten meal contains the most protein ; gluten feed and germ oil meal come between these two. These products differ so widely and there is, moreover, such diversity in the application of names to different products that it is necessary to inquire as to the composition before purchase.

(*e*) *By-products from the manufacture of oils* — A large number of different seeds are used for the production of oil but the only ones which are of much importance in the United States are cotton seed and flax seed. Both of these are valuable food stuffs containing a larger proportion of protein than any others which are available. Cottonseed meal is the richer of the two. It is not, however, as safe food as linseed meal. It can be used only in rather moderate quantities. If fed in too large amounts it disturbs digestion and is likely to cause inflammation of the udder in case of milch cows. When fed to milch cows it tends to make their butter soft and it is likely to cause constipation, if largely fed. Linseed is much safer. Its tendency is laxative. When fed to milch cows the butter from their milk is rendered comparatively soft. Cottonseed meal is an unsafe food for pigs.

741. *Classification of concentrates according to the proportion of nutrients* — In the making up of rations it will be found convenient to have at hand a classified list of concentrates in order that one may the more readily find a ration which is rich, poor, or medium in protein as may be needed to bring it to the desired standard. Undoubtedly one of the best classifications which has been proposed is the one by Lindsey* which recognizes two divisions and four classes, as follows : —

* Bulletin 71, Hatch Experiment Station.

DIVISION I — Protein Feeds.			DIVISION II — Starchy (Carbohydrate) Feeds.
Class I.	Class II.	Class III.	Class IV.
30–45% protein. 50–60% carbohydrates.* 75–90% digestible.	20–30% protein. 60–70% carbohydrates.* 80–85% digestible.	14–20% protein. 70–75% carbohydrates.* 60–75% digestible.	8–14% protein. 75–85% carbohydrates.* 75–90% digestible.
Cottonseed meal. Cleveland flax meal. N. P. and O. P. linseed meals. Chicago, Cream, and King gluten meals.	Buffalo, Davenport, Golden, Rockford, Diamond, Waukegan, and other standard gluten feeds. Atlas meal, dried brewers' grains, and malt sprouts.	Wheat middlings, mixed feed, and wheat bran. H. O. Dairy feed.	Wheat, rye, barley, oat, corn, and hominy meals. Oat, corn and oat, and corn, oat, and barley feeds. Quaker dairy and H. O. horse feeds.

* Including fat reduced to carbohydrates.

By reference to these groups one can at once see about what effect the particular food stuff will have upon a ration ; to what extent, for instance, it will serve to enrich in protein a mixture of materials consisting chiefly of carbohydrates.

742. *What feeds to buy* — The farmer must of course consider cost as well as composition in his purchase of food stuffs, and relative cost differs to some extent from time to time according to the laws of supply and demand. Recognizing this fact, Lindsey has devised a key whereby it is believed the farmer may, for himself, knowing the prices, determine which of any number of feeds it will be best for him to purchase. This key follows : —

KEY TO COMPARATIVE VALUE OF CONCENTRATED FEEDS.

Cottonseed meal	152	Protein feeds.	Mixed feed*	90–95
Cleveland flax meal	134		Wheat bran	86
O. P. linseed meal	138		Malt sprouts	95
Gluten meal	140		Dried brewers' grains	100
Wheat middlings†	107–114		H. O. dairy feed	96
Corn meal	100	Starchy (carbohydrate) feeds.	Quaker dairy feed	84
Hominy meal	105		Corn and oat feed	90
Ground oats	90		Corn, oat, and barley feed	92
Oat feed (best grades)	70		H. O. horse feed	90
Oat feed (excessive hulls)	40–50			

* Estimated but not actually determined.

† Fine, light-colored middlings with 18 to 20 per cent. protein.

In making up this key, corn meal has been taken as a standard, and its value is placed at 100. In explaining the use of this key we cannot do better than to quote Lindsey.

"*How to Use the Key.*

"It is not possible in this connection to show the relative *effects* of the various feed stuffs on the flow of milk or the production of beef. The figures are offered rather as a key to the comparative commercial values of the different feeds based on the digestible nutrients contained in them. Thus, if wheat bran is worth 86, cottonseed meal would be worth 152. These figures can be easily converted into dollars. Thus, if corn meal is worth $20.00 per ton or 100, wheat bran would be worth 86 per cent. of $20.00 or $17.20, the amount the farmer can afford to pay for the bran. Again, with cottonseed meal worth $25, what can the farmer afford to pay for old process linseed meal? Cottonseed meal equals 152, or $25, and linseed meal 138. We have a case in simple proportion: 152 : 138 : : $25 : x = $22.70, the value of a ton of linseed meal. It must not be forgotten that these figures do not take into consideration the mechanical condition, or the particularly favorable effect which some feeds are supposed to exert upon the general health of the animal."

At the present time (and the same has been true as a rule for some years), the following are among the most economical concentrates which are rich in protein: cottonseed meal, corn gluten meal, gluten feed, dried brewers' grains, malt sprouts, and fine middlings.

Discussing the topic "expensive feeds," in Bulletin 71, Lindsey says: —

"Wheat bran and mixed feed contain only 13 per cent. of digestible protein, and 35 to 40 per cent. of indigestible matter. The long distance transportation of substances containing such a large amount of inert material is an important factor in making the nutrients they contain relatively expensive. While they are safe to feed and are most excellent for diluting or 'lightening up' the more concentrated by-products, it is believed that farmers often feed them in excess to their pecuniary disadvantage. For milkmen they often furnish a partial and cheap substitute for hay, when the latter is expensive. The above remarks apply to New England conditions,

as these products are undoubtedly among the very cheapest feeds for Western farmers. Linseed meal, while a desirable producing feed, is as a rule an expensive one. It is not economical for the average farmer to *purchase* corn meal for milk production ; it should be grown upon the farm. Milk producers, who are obliged to purchase all of their feed, can on the contrary often feed grain mixtures containing one-third corn or hominy meal to advantage. Among other expensive concentrates may be mentioned oat feeds, and the various mixtures containing considerable quantities of oat offal. For obvious reasons it is generally decidedly more economical for farmers to make their own mixtures."

CXXIV — FEEDING IN SUMMER.

743. *General considerations* — In the feeding of the horse and the hog the practice of most men need not be materially different in summer from that in winter, although these animals might doubtless be pastured in many cases to a greater extent than is usually the case. Sheep, of course, as a rule, depend exclusively upon pasture in summer. The same is true of young cattle under ordinary conditions. Milch cows in many cases are made to depend almost exclusively upon pasture for summer feed. If the pasture furnishes abundance of sweet, nutritious grasses, it leaves little to be desired, so far as its influence upon product is concerned, and but a comparatively small amount of concentrates can, with advantage, be fed in connection with such pasture. In the New England states the proportion of steep and rocky hillsides furnishing a large amount of rich herbage is so great that cows are for the most part pastured ; but in localities where a larger proportion of the farm areas is tillable, or under an intensive system of farming, soiling is becoming increasingly common. In many localities, it is true, pastures may be insufficient either throughout or during only a part of the season, and partial soiling is practiced.

744. *The advantages of soiling* — Among the more important of the advantages connected with soiling are the following : —

1st. More feed is produced per unit of area than by pasturage. An experiment by Armsby showed that two soiling crops in one season (rye fol-

lowed by corn) yielded five times as much digestible matter on a given area as good pasture sod.

2d. Grazing is wasteful because a considerable proportion of the grass produced is trampled down and rendered unpalatable by dung and urine.

3d. There is a great saving in the matter of fencing.

4th. The animals can be kept in greater comfort, better protected from flies, and from the intense heat of the sun.

5th. The supply of manure is increased.

745. *Systems of soiling* — From the fact that the labor cost of handling green crops throughout the entire season is considerable and that the work comes at a time when the forces of the farm are apt to be otherwise fully employed, many have come to the conclusion that silage is the best crop which can be used for such feeding and experience indicates no apparent serious disadvantage from its continued use. There can be no doubt, however, that animals as well as persons relish a change in diet, and to the writer it seems desirable that fresh, green crops should be used for a part of the summer at least. A number of different systems for soiling, each of which has many merits, have been proposed. Among these one suggested by Phelps of Connecticut, another by Voorhees of New Jersey, and one which has been carefully tried by Lindsey in central Massachusetts are given : —

CONNECTICUT SCHEME.

Species of Crop.	Time of Seeding.	Approximate Time of Feeding.
Winter rye	Sept. 1	May 10–20
Winter wheat	Sept. 5–10	May 20–June 5
Clover	July 20–30	June 5–15
Grass (from meadows)		June 15–25
Oats and peas	April 10	June 25–July 10
Oats and peas	April 20	July 10–20
Oats and peas	April 30	July 20–Aug. 1
Hungarian	June 1	Aug. 1–10
Clover, rowen		Aug. 10–20
Soy beans	May 25	Aug 20–Sept. 5
Cow peas	June 5–10	Sept. 5–20
Rowen grass (meadows)		Sept. 20–30
Barley and peas	Aug. 5–10	Oct. 1–30

NEW JERSEY SCHEME.

Species of Crop.	Time of Seeding.	Approximate Time of Feeding.
Winter rye	Sept.	May 1–10
Winter wheat	Sept.	May 10–20
Crimson clover	Sept.	May 20–June 1
Oats and peas	April 1	June 1–10
Oats and peas	April 10	June 10–20
Mixed grasses	Sept.	June 20–30
Oats and peas	May 10	July 1–10
Cow peas	May 20	July 10–20
Corn	June 1	July 20–Aug. 1
Japanese millet	June 20	Aug. 1–10
Cow peas	June 10	Aug. 10–20
Corn	June 20	Aug. 20–Sept. 1
Soy beans	July 10	Sept. 1–10
Japanese millet	July 20	Sept. 10–20
Corn	July 1	Sept. 20–Oct. 10
Barley and peas	Aug. 10	Oct. 10–20
Barley and peas	Aug. 20	Oct. 20–30

SUMMER FORAGE CROPS.

(Data for ten cows' entire soiling.)*

Kind.	Seed for an Acre.	Approximate Time of Seeding.	Area.	Approximate Time of Cutting.
Wheat and winter vetch	1½ bush. wheat, 1 bush. vetch	Sept. 1	½ acre	May 25–June 8
Wheat**	2 bush	Sept. 1	½ acre	May 25–June 8
Grass mixture and clover.	8 lbs. clover, 8 lbs. tall oat grass, 6 lbs. orchard grass, 6 lbs. Kentucky blue grass	Aug.	⅔ acre	June 10–June 25
Clover†	15–20 lbs	Aug.	⅔ acre	June 10–June 25
Oats and peas	1½ bush. each	April 20	½ acre	June 25–July 6
Oats and peas	1½ bush. each	May 5	½ acre	July 6–July 17
Oats and peas	1½ bush. each	May 20	½ acre	July 17–July 28
Japanese barnyard millet and peas	8 qts. millet, 1½ bush. peas	May 15	⅓ acre	Aug. 1–Aug. 10
Japanese barnyard millet ‡	14 qts	June 5	⅓ acre	Aug. 10–Aug. 20
Corn and soy beans	10 qts. corn, 7 qts. beans	May 15	½ acre	Aug. 20–Sept. 4
Corn and soy beans	10 qts. corn, 7 qts. beans	June 5	½ acre	Sept. 4–Sept. 20
Barley and peas	1½ bush. each	July 25–Aug. 1	⅔ acre	Oct. 5–Oct. 20

* It is understood that the time of seeding, area to be seeded, and yield to the acre will be governed somewhat by the weather conditions and the fertility of the soil.

** Instead of wheat and vetch, if vetch is too expensive.

† In place of grass and clover if desired.

‡ Leave out peas in this sowing.

746. *Feeding for milk production* — In what has preceded the rations which have been figured as illustrative examples of ration-making have been for the dairy cow in most of the instances, and references have had relation also to the feeding of this animal. Many of the points in connection with feeding for milk must, therefore, have been made clear. There are a few special points, however, which must be briefly considered.

The question as to whether variations in the nature or quality of the food will lead to the production of milk of varying composition has been much investigated. The opinion has been generally held that when the cow is fed upon succulent feeds such as pasture grass, her milk will be less rich in total solid constituents than when the animal is fed upon dry foods. Acting upon this belief or influenced by the farmers, a different standard has been fixed by the legislatures in some states for summer and winter milk. It may be doubted whether such variation is wise. Careful investigation indicates that, so long as the food of the cow is fairly sufficient in quantity and in kind, the quality of her milk is not likely to vary materially in respect to total amount of solids which it contains. Further, it has been held by some that by variation in food it is possible to change the relative proportion of the constituents, such as sugar, casein, and especially fat found in milk. It has been thought that giving foods rich in fat might be a valuable means of securing a milk rich in this element, and therefore more valuable for butter making. Investigation has shown that increase in the proportion of fat in foods does not permanently affect the percentage of fat in a milk. On being given food exceptionally rich in fat, the cow may, for a time, produce milk abnormally rich in that constituent ; but in all cases the proportion of fat soon decreases to about the normal proportion, and, since feeding foods exceptionally rich in fat is attended with danger of derangement of digestion, and other possible ill effects, it must be concluded that this plan of securing milk rich in butter fat has nothing to recommend it. The quality of the butter produced by cows, however, is influenced in marked degree by the nature of the food. Allusion has been made to this point in speaking of cottonseed and linseed meals. We may add here to the information already given that gluten meal and feed tend to soften butter fats, and that corn meal

usually produces butter fats of very satisfactory character. As a rule, a mixture of grain feeds is safer than reliance upon any single feed. The effect of foods having very distinctive and strong odors and flavors upon the flavor of milk products is very marked. Silage, especially that which is poorly made, turnips, cabbages, rape, and similar foods may all give their characteristic flavors to milk. In many cases such flavors are acquired by milk by absorption of the odors that are present in the air of the stable. They are by no means always transferred through the body of the cow, although they may be so transferred. Careful scientific experiments and the experience of many practical men, however, indicate that, if any of these foods be used in reasonable quantities, and given just after and not shortly before milking, little influence on the flavor of the milk can be noted. The practical man, then, will avoid handling silage, turnips, etc., in a stable during milking or immediately before milking, and he will take the precaution to give such foods after instead of before milking.

Conclusive evidence is afforded by a recent bulletin from the Rhode Island Experiment Station (No. 77) that farmers frequently feed unwisely, using as a rule more corn meal than it is economical to employ, and feeding accordingly a ration with too wide a nutritive ratio. A large number of rations as reported by farmers are published in the bulletin, side by side with rations using, in most cases, the same roughage as modified on suggestion of the experiment station workers. A few examples are given below: —

Daily Ration from Bristol, R. I., for 750-Pound Cows.

As Reported.			*As Modified.*		
7.2	pounds	corn meal.	2.9	pounds	corn meal.
2.9	"	oatmeal.	1.9	"	bran.
1.9	"	bran ("shorts").	2.0	"	Chicago gluten meal.
25.0	"	beets (supposed to be mangel-wurzels).	25.0	"	mangel-wurzels (beets).
12.5	"	corn fodder.	12.5	"	corn fodder.
4.0	"	mixed hay.	4.0	"	mixed hay.

The ration contains :—	*The ration contains :—*
23.27 pounds dry matter.	18.93 pounds dry matter.
1.73 " protein.	1.91 " protein.
15.30 " carbohydrates and fat.	11.09 " carbohydrates and fat.
Nutritive ratio, 1:8.9.	Nutritive ratio, 1:5.8.

Corn fodder was fed twice each day and hay once.

DAILY RATION FROM JAMESTOWN, R. I., FOR 800-POUND COWS.

As Reported.	*As Modified.*
3.2 pounds middlings.	3.0 pounds Chicago gluten meal.
6.4 " corn meal.	4.2 " middlings.
12.5 " corn fodder.	4.0 " corn meal.
4.0 " mixed hay.	12.5 " corn fodder.
	4.0 " mixed hay.

The ration contains :—	*The ration contains :—*
18.80 pounds dry matter.	20.24 pounds dry matter.
1.31 " protein.	2.24 " protein.
12.66 " carbohydrates and fat.	12.98 " carbohydrates and fat.
Nutritive ratio, 1:9.7.	Nutritive ratio, 1:5.8.

Corn fodder was fed twice a day and hay at noon.

DAILY RATION FROM JAMESTOWN, R. I., FOR 900-POUND COWS.

As Reported.	*As Modified.*
3.0 pounds corn meal.	3.0 pounds corn meal.
1.0 " bran.	1.0 " bran.
16.0 " turnips.	2.0 " cottonseed meal.
12.0 " mixed hay.	1.0 " Chicago gluten meal.
18.0 " corn stover.	16.0 " turnips.
	4.5 " mixed hay.
	18.0 " corn stover.

The ration contains :—	*The ration contains :—*
26.10 pounds dry matter.	22.40 pounds dry matter.
1.25 " protein.	2.04 " protein.
15.10 " carbohydrates and fat.	13.10 " carbohydrates and fat.
Nutritive ratio, 1:12.1.	Nutritive ratio, 1:6.4.

"This nutritive ratio was so wide that it was necessary to feed large amounts of material daily in order to supply the amount of protein demanded by cows giving a full flow of milk."

To such as do not care to take the trouble to figure rations the method of feeding milch cows recommended by Lindsey will be of interest. Lindsey gives a list of what he considers desirable grain mixtures, with directions

as to the quantity needed by animals of average size (about 900 pounds), and the conditions under which each mixture should be used.

DESIRABLE GRAIN MIXTURES.

I.

100 pounds cottonseed or gluten meal.*
125 " flour middlings.
100 " wheat bran or mixed feed.
Mix and feed six to seven quarts daily.

II.

250 pounds gluten feed.
100 " wheat bran or mixed feed.
Mix and feed eight quarts daily.

III.

5 to 6 quarts gluten feed daily scattered on the silage.

IV.

100 pounds fine middlings.
100 " brewers' grains or malt sprouts.
Mix and feed 6 to 8 quarts daily.

V.

100 pounds cottonseed or gluten meal.
150 " corn or hominy meal.
100 pounds wheat bran or mixed feed.
Mix and feed 6 to 7 quarts daily.

For Summer Feeding to Help out Pastures.

VI.

100 pounds gluten feed.
100 " wheat bran or mixed feed.
Mix and feed 4 to 6 quarts daily.

VII.

100 pounds gluten feed.
100 " hominy feed.
Mix and feed 4 quarts daily.

* Or linseed if not too expensive.

It is to be understood that the quantity of these grain mixtures to be used should be varied with the appetite and digestive capacity of the cow and that it may wisely be larger in proportion as the cow is giving more milk.

Jordan gives the following as examples of well compounded rations for cows of moderate size and fairly large productive capacity : —

I.

10 pounds clover hay.
35 " corn silage.
2 " hominy chops.
4½ " wheat bran.
2½ " linseed meal, N. P.

II.

10 pounds mixed meadow hay.
40 " corn silage.
4 " wheat middlings.
3 " malt sprouts.
1 " gluten meal.

III.		IV.	
6 pounds	clover hay.	10 pounds	corn stover.
10 "	mixed meadow hay.	5 "	alfalfa hay.
25 "	mangels.	25 "	sugar beets.
3 "	corn meal.	3 "	corn and cob meal.
2 "	wheat bran.	3 "	buckwheat middlings.
2 "	brewers' grains.	1½ "	cottonseed meal.
2 "	gluten meal.		

V.

12 pounds	clover or alfalfa hay.	3 pounds	ground peas.
30 "	corn silage.	2 "	brewers' grains.
4 "	ground oats.		

747. *Feeding growing animals* — The growing animal must receive in its food the elements necessary to build up new tissues (bone, flesh, etc.). Such animals require, then, abundance of protein and mineral matter. Some have believed it to be possible to influence the relative proportion of fat and lean produced by the growing animal in marked degree by suitable modifications in feeding. It has been thought that if foods exceptionally rich in protein predominated the body would be rich in lean meat and that foods exceptionally rich in carbohydrates and fat would lead to the production of a carcass excessively rich in fat. It does not appear, however, if we may base an opinion upon what seem to be the most careful experiments, that the differences produced by such modifications in feeding are important unless the rations are made extremely one-sided.

Mother's milk is, of course, the typical food for the young animal. Substitutes for it are often cheaper in the case of the cow and if such substitutes are used they should be selected with a view to obtaining a food which will approximate milk in composition as closely as may be. The young animal should not at first receive much bulky food, as the stomach and intestines are not fitted either to hold or to digest and assimilate such foods.

(*a*) *Feeding calves* — If the calf is to be fattened for veal, then in most cases it should be on new milk. The calf, without doubt, will do better if it takes this milk directly from the cow, but with suitable attention to cleanliness, regularity in feeding, and the proper temperature of the milk the calf

will do well when fed artificially ; and it will be better for the development of the cow that she be milked, rather than that a calf should suckle her. Skillful feeders fatten veal calves successfully on other foods than new milk. Cow's milk is a costly food and, when calves are to be reared for breeding or other purposes, some substitute for it must usually be looked for. Skim milk, which of course must be sweet, is the most satisfactory basis in calf feeding. While the calf can be reared on skim milk alone, it will not do as well as when this is mixed with some suitable porridge. Among all the various materials which have been tried, flaxseed meal is by general consent the best. The change from new milk to a mixture of skim milk and flaxseed porridge should always be gradually made. Among the various rules for combining flaxseed meal and skim milk that given by Jordan appears to be one of the best.

"An admirable mixture is prepared by cooking the flaxseed meal in water in the proportion of 1 to 6 by volume and adding a small amount of this (the equivalent of 3 or 4 tablespoonfuls of dry meal at first) to 18 or 20 pounds of warm skim milk, which may serve as a day's ration. The quantity of meal should be gradually increased up to 1 pound a day inside of a few weeks."

In addition to this feed the calf should be taught to eat dry meal as early as possible. Among the kinds suited to its needs oatmeal and middlings are best. In feeding these care should be taken not to give an amount in excess of what the animal will consume in a day, and the feeding box should be kept sweet and clean. A little fine, sweet hay, or grass if in season, will be eaten after the animal is a few weeks old.

(*b*) *Lambs* — Lambs are, unless prevented by accident, invariably kept with their dams, and take their food in nature's way. The ewes, especially if many of them are suckling twins, will need to be very liberally fed. Fine clover, alfalfa, or rowen hay are the most valuable roughages. The ewes should as a rule have about three-fourths of a pound each daily of mixed grains, these being selected in accordance with the same laws as those applicable in the case of cows. Roots, especially turnips, in moderate quantities will also be found very useful in stimulating a large flow of milk. If it is the

object of the feeder to fatten lambs as early as possible for market, they should be provided with a separate pen into which the sheep cannot enter, and fed as much of a mixture of different meals as they will take. Corn meal, gluten meal and feed, ground oats, wheat bran and linseed are all suitable. Corn meal should be freely used only in case the lambs are to be fattened. If they are to be reared for breeding stock, corn meal should be sparingly used, if at all, and oatmeal more largely employed.

(*c*) *The colt is practically always reared with the dam* — If the season allows pasturage and the feed is good, both mare and foal will do well on grass alone ; but if stabled particular attention must be paid to selection of foods of the best quality for the mare, for unless she gives a liberal amount of milk the growth of the foal will be slow. The value of the future horse depends, in large measure, on the animal's growing in a rapid and healthy manner from the start. The mare, then, should have the best of hay and a liberal allowance of grain. Jordan recommends a mixture : —

Ground oats,	4 parts
Middlings,	5 parts
Linseed meal,	1 part

The colt will soon learn to eat with the dam and should be encouraged to do so, but as soon as the animal begins to eat freely he should be separately fed, and most feeders agree that ground sound oats constitute the best and safest feed. Jordan advises (mainly because it will be cheaper) a mixture : —

Oats,	4 parts
Middlings or bran,	4 parts
Pea meal,	2 parts

Skim milk may be fed to the colt in moderation with favorable results after it reaches the age of three or four months and especially at the time of weaning. It is regarded as a mistake to feed a colt so largely on concentrates that it will consume too small an amount of hay and other coarse feeds. It is best for the future usefulness of the animal that it be so fed as to cause a moderate distention of the stomach and intestines.

748. *Feeding for the production of meat* — Meat production in the

United States is mainly confined to the Mississippi Valley and farther west. In the Northeastern states this branch of agriculture is of comparatively little importance. With the increasing prices of late years, however, it seems not unlikely that the fattening of beef and mutton in the East may once more become generally profitable. Indeed, there are numerous examples of men successful in this branch of animal industry, even in the most thickly settled Eastern states. In the opinion of Jordan the German standards for fattening cattle call for a larger amount of food than the average animal will consume, and he gives a number of sample rations which are quoted as examples of what he regards as suitable foods for fattening animals. He advises for the full feeding of fattening steers, weighing approximately 1,000 pounds each at the beginning of the feeding period, the following among other rations : —

I.		II.	
5 pounds	clover hay.	8 pounds	mixed hay.
16 "	corn silage.	12½ "	corn meal.
13 "	corn meal.	3 "	wheat bran.
3 "	wheat bran.	2 "	oil meal or gluten feed.

III.		IV.	
8 pounds	alfalfa hay.	5 pounds	mixed timothy and clovers.
12 "	corn meal.	30 "	silage.
5 "	ground oats.	13 "	oats and peas.

It will be noticed that corn meal is a prominent ingredient in all except one of these rations, and in that silage (presumably well-eared corn) is one of the chief constituents of the ration. In all, then, corn is mainly depended upon.

In conclusion on this subject attention is called to the fact that since for profitable fattening the animal must be made to consume as large an amount of food as possible, in order that the length of time required may be shortened (a point highly essential to profit), the foods must be made as palatable as possible, and, further, they must be such as are easily digested.

749. *Feeding for pork production* — In the great majority of instances in the older states, in all of which dairying is prominent, skim milk will be largely used in feeding swine. Indeed, many experiments indicate that a

combination of skim milk and corn meal in suitable proportions, fed in accordance with the appetite of the animal, will give as satisfactory results as any other method of feeding. Goessman, as the result of numerous experiments in Amherst, makes the following recommendations : —

Weight of Pigs. Pounds.	Food.	Nutritive Ratio.
20 to 80	2 ounces corn meal to each quart of milk.................	1:3.30
80 to 125	4 ounces corn meal to each quart of milk.................	1:4.00
125 to 190	6 ounces corn meal to each quart of milk.................	1:4.50

It is to be understood that the animals should be fed as much of this mixture as they will take and maintain good appetites for their food. When skim milk is not available in sufficient quantity, Goessman recommends feeding in either of the two following methods : —

Weight of Pigs. Pounds.	Food.	Nutritive Ratio.
	I.	
20 to 80	Milk at disposal, and a mixture consisting of one part, by weight, of wheat bran to two parts gluten meal, to satisfy the appetite....................................	1:3.20
80 to 120	Milk at disposal, and a mixture consisting of one part each, by weight, corn meal, wheat bran, and gluten meal, to satisfy the appetite....................................	1:4.00
125 to 190	Milk at disposal, and a mixture consisting of two parts, by weight, of corn meal, one part wheat bran, and one part gluten meal, to satisfy the appetite....................	1:4.50
	II.	
20 to 80	2 ounces corn meal to each quart of milk, and 4 ounces gluten feed as a substitute for each quart of milk.......	1:3.25 to 4.00
80 to 120	6 quarts of skim milk in a mixture, one part, by weight, gluten feed and one part corn meal....................	1:4.00 to 4.40
125 to 190	6 quarts of skim milk to a mixture, one part, by weight, gluten feed and one and one-half parts corn meal.......	1:4.4 to 4.9

The Massachusetts Ploughman reports recently some results obtained by a Vermont farmer in feeding skim milk to pigs. This farmer kept twenty Jersey cows. He used all the milk needed to raise several calves and fattened and sold thirty pigs. With his skim milk he fed 3 tons of corn meal costing $55. The pigs purchased as weanlings cost $57, a total out-

lay of $112. The pigs were fattened and sold at from five to six months old at an average of more than $10 each. He received $210 for his skim milk and his labor. The manure would largely repay for the labor. This farmer estimated that the skim milk fed the pigs proved worth from 25 to 32 cents a hundred pounds.

As a result of his experiments Henry concluded that 462 pounds of skim milk effected a saving of 100 pounds of corn meal. Knowing the cost of corn meal, the farmer on this basis can readily estimate what skim milk is worth for making pork. Henry found that the use of these two feeds, in the proportion of one pound of corn meal to one to three pounds of skim milk, resulted in the production of a pound of pork on a smaller number of pounds of digestible nutrients than grains alone or corn meal and skim milk in any other proportions.

Experiments indicate that the oil meals are not well adapted as food for hogs.

Of late years increasing attention has been given to forage crops for swine, and among those which have been tried with satisfactory results clover, alfalfa, rape, sorghum, and a mixture of oats and peas have all been found satisfactory. The pig, however, needs grain in addition to green forage in order to make satisfactory growth, but there is much evidence to show that when pastured on suitable forage crops and given grain in addition pork can be very cheaply made. Especially does this system of management recommend itself in the case of breeding animals.

750. *Feeding for work* — As shown by the standards, Table I, Appendix, the quantity of food and the proportion of the nutrients needed by the working animal should be varied in proportion to the amount of work. The horse (or mule) is now almost exclusively depended upon by American farmers for work. The feeding of these animals is comparatively simple. Mixed grains and most of the by-products are but little used. The main reliance is placed upon good, sound hay (timothy almost invariably preferred) and sound oats or oats and corn. There is no concentrate perhaps safer for the horse than oats and for driving horses this grain is to be preferred to any other. For work horses a mixture of equal parts, by

weight, of oats and corn is preferred by many. At prevailing prices oats are more costly than most other foods. Among foods which may be used as a partial substitute in order to secure greater economy, dried brewers' grains, wheat bran, middlings, and N. P. linseed meal may be used. As examples of rations which will commonly be found sufficient for a horse weighing 1,000 pounds, at moderate work, the following are quoted from Jordan: —

I.
10 pounds timothy or mixed hay.
11½ " oats.

II.
10 pounds hay.
10½ " oats and corn in equal parts by weight.

III.
10 pounds hay.
8 " oats.
4 " brewers' grains.

IV.
10 pounds hay.
8 " oats.
4 " wheat bran.

V.
10 pounds hay.
5 " corn.
6½ " wheat bran.

The horse will relish an occasional feeding of roots or even of sound silage. In summer, when these foods are not usually available, an occasional feed of green grass will be highly relished, and will have a favorable effect upon the animal's appetite and health.

751. *A few practical hints* — Whatever the animal is fed, regularity in hours of feeding, as well as in amounts of food given, is of much importance. Unless regularly fed, animals become uneasy, and fail to do their best in consequence. As to how many times animals should be fed daily or how the food should be divided, there is much divergence in opinion and practice. In the case of cattle many hold that these animals will do best when given two full meals daily, as this method allows plenty of time for rumination. Certain it is that animals will do well on this system, but it seems to the writer expedient to give also a little food at noon. In the case of horses all are practically agreed that these animals should be fed three times daily, but many of the best horsemen hold that the food should not be evenly divided; that the animal should receive considerable more food at night

(especially of the coarser foods) than in the morning or at noon. The horse requires considerable time for proper mastication of its food, and this plan appears to have decided merits.

Brood sows and young pigs may, with advantage, be fed three times daily, but fattening hogs and ordinary stock do well if fed but twice.

Sheep should be fed in the same manner as recommended for cattle.

Perfect cleanliness also should be observed in all the details of management connected with feeding. To allow mangers, feed boxes, or troughs to become sour and filthy, as they surely will do if food in excess of the requirements of the animals is given at any time, is to render all food later given to a certain extent unpalatable. It is also in the case of calf feeding where milk is used not unlikely to prove a source of serious digestive disturbances. Much might be said concerning the order of giving different foods and combinations of different foods, but space will not permit. There is considerable evidence to show that concentrates are better digested, especially by ruminants, if sprinkled on or mixed with coarse feeds which are of such character as to make this practicable. Many, accordingly, sprinkle such feed on chaffed roughage or silage. Good results are undoubtedly obtained also by giving these two classes of food separately. If this plan is followed the concentrates are usually given first.

CXXV — DAIRY HUSBANDRY.

752. *Introduction* — The importance of dairy farming in some of its various branches in all the older states is well known. Taking the United States as a whole it ranks as one of the most important of the branches of agriculture. Alvord gives the following estimate of the number of cows and quantity and value of dairy products in the United States for the year 1899 :—

ESTIMATED NUMBER OF COWS AND QUANTITY AND VALUE OF DAIRY PRODUCTS.

Cows.	Product.	Rate of Product Per Cow.	Total Product.	Rate of Value. Cents.	Total Value.
11,000,000	Butter	130 lbs.	1,430,000,000 lbs.	18	$257,400,000
1,000,000	Cheese	300 "	300,000,000 "	9	27,000,000
5,500,000	Milk	380 gal.	2,090,000,000 gal.	8	167,200,000

The total value of the dairy products of the country as shown by this table is $451,600,000. If to this total be added the skim milk, the buttermilk, and whey at their proper feeding value, and the annual value of the calves, the aggregate value of the product of the dairy cows of the United States exceeds $500,000,000. The New England and Middle states are peculiarly fitted in soil and climate, as well as in the character of the natural herbage produced by the pastures and because of the abundance and universal distribution of natural supplies of pure water, for the production of milk of high quality. These states are equally fitted in all natural features and in climate to the manufacture of milk into butter and cheese of the best grades. The relative density of population of these states, however, creates a home market for enormous quantities of milk and cream. The great cities — ever growing — reach out farther and farther for their supplies. Boston, for example, draws milk daily from the extreme west of Massachusetts, from Vermont, New Hampshire, Maine, and Connecticut. The daily consumption of milk in that city is, according to the best estimate available, about one pint to each individual. As the population of our cities and manufacturing towns increases, it will readily be seen that the proportion of milk which can be produced in the older states, which will be required to supply the urban population, must increase rapidly. Although improved facilities of transportation make it possible for cities to draw their milk and cream supply from ever-increasing distances, it is evident that the sections immediately adjacent to the great centers of population must always have a great advantage in supplying these centers with fresh milk and cream. For all these reasons as well as because cheese and butter are now comparatively little made in the home, the subjects here to be considered will pertain chiefly to the conditions essential to the economical production of milk and cream of good quality and the placing of them in the hands of consumers. Butter making and cheese making are now, for the most part, carried on in factories and creameries. A complete discussion of either would require a volume. Such discussion is, however, clearly uncalled for in a work intended for farmers. Some of the most important subjects connected with dairy farming have already been considered in this volume ; the various

breeds of dairy cows have been described, their special characteristics and adaptations have been stated, methods of breeding have been discussed, and, under the general subject feeding, a very large proportion of space has been devoted to a consideration of the proper feeding of the milch cow.

CXXVI — MILK.

753. *Nature and general composition* — Milk is a whitish, opaque fluid. It consists of a transparent liquid called serum and minute fat globules of various sizes. The serum consists of water in which are dissolved all the other constituents except fat, viz.: sugar, casein, and albuminoids, and mineral matter or salts. The fat globules are semi-solid. They are intimately mixed with the serum, forming with it what is called an emulsion. The fat globules average about .0001 of an inch in diameter but they vary widely and to a considerable extent in the milk of each individual cow. The differences in the average size in the milk of different breeds have been pointed out (see description of dairy breeds).

The constituents of milk other than water considered collectively are spoken of as milk solids. The proportion of the various constituents in milk is subject to considerable variation. The following taken from Wing will give an idea of the usual composition: —

	American. (Babcock.)	English. (Oliver.)	German. (Flieschmann.)	French. (Cornevin.)
Water	87.17	87.60	87.75	87.75
Fat	3.69	3.25	3.40	3.30
Casein	3.02	3.40	2.80	3.00
Albumin	.53	.45	.70	....
Sugar	4.88	4.55	4.60	4.80
Ash	.71	.75	.75	.75
Total	100.00	100.00	100.00	99.60

The following from Kœnig shows the range of variation of the several constituents in nearly 800 analyses collected from all parts of the world: —

	Maximum.	Minimum.		Maximum.	Minimum.
Water	90.69	80.32	Albumin	1.44	.25
Fat	6.47	1.67	Sugar	6.03	2.11
Casein	4.23	1.79	Ash	1.21	.35

"While the range of variation shown above is considerable, some of the constituents, notably the fat, may show even greater ranges in milk secreted by normal, healthy cows. It is probable that the minimum of Kœnig is seldom reached, but as high as 10 per cent. of fat has been found in the milk of single cows giving a very small quantity. Babcock states that no analysis showing more than 9 per cent. of fat is recorded from any cow giving as much as 15 pounds of milk per day. Any analysis above 7 per cent. is extremely rare, and should be regarded with suspicion unless well authenticated. The mixed milk of herds seldom falls below 3 per cent. of fat and rarely rises above 5.5 per cent.'

Of the various constituents of milk the ash and sugar vary least; the fat and albumin most; casein is commonly present in quite definite proportions as compared to the fat, *i. e.*, when there is more fat there is more casein, and *vice versa.*

754. *The specific gravity of milk* — The constituents of milk other than fat are heavier than water ; the fat is lighter. In general, milk which contains a high proportion of total solids will have a high specific gravity, although if the large proportion of total solids is due chiefly to the high percentage of fat the specific gravity may be lessened. The variation in specific gravity between different samples of milk is considerable, the usual range being from about 1.029 to 1.035 at 60° F., the average being about 1.032. The determination of the specific gravity was formerly regarded as a valuable means of detecting adulterations in milk but it is entirely possible to remove a portion of the fat or cream and to add water in such a way that the specific gravity will remain the same as that of normal milk. Less attention, accordingly, is paid to specific gravity than formerly.

755. *Character of the solid constituents of milk* — Milk sugar has the same composition as cane sugar, but it does not crystallize as readily. It has less sweetening power than ordinary sugar. Under the influence of ferments usually found in milk it is readily changed into acid, which is known as lactic acid. It is the formation of this acid which causes milk to become sour.

The albuminoids — Casein is the chief albuminoid of milk, though there

is always a small amount of albumin and, according to some authorities, fibrin also. Casein is the constituent of most importance in cheese making. In the opinion of some casein is not actually dissolved in the milk but exists rather in the form of a colloid. If a weak organic or mineral acid or rennet be added to milk the casein coagulates and forms a curd.

The mineral constituents — The chief mineral constituent of milk is phosphate of lime, though it contains also chlorids of soda and potash. Milk contains also a very minute quantity of citric acid, and a coloring substance, which is more abundant when the cow is fed on green feeds.

756. *The viscosity of milk* — The term viscosity is used to designate that characteristic of milk which gives it a quality resembling that of very dilute mucilage. This quality is due to the sugar and fibrin which it contains. Viscosity tends to increase with the age of the milk. The more viscous it becomes the less easily can the cream be separated from it.

757. *Colostrum* — The first milk yielded by the cow after calving is called colostrum. It has the appearance of being very rich but it is relatively poor in butter fat. The percentage of albumin is large and with the casein often comprises about 15 per cent. of the total. The percentage of sugar in the colostrum is low. The time that should be allowed after calving before the milk is used varies with conditions and the purpose for which the milk is to be used. The Walker-Gordon Company, which aims to produce milk for special customers of the very highest possible quality, discards milk for one week after calving. The Boston Dairy Company instructs its farmers to discard two milkings. The varying practice of these two companies represents the two extremes. For ordinary purposes, where the milk from the whole herd is generally mixed and the cow which has newly calved is in normal condition, the milk can safely be used the third day. If for any reason the milk does not appear normal, or in case the cow does not clean well, the milk should be discarded for a longer time.

758. *Conditions exerting an influence on the quality of milk* — A considerable number of conditions may cause a variation in the quality of the milk of the same cow. The more important of these must be considered.

(*a*) *Variations due to progress in lactation* — By the period of lactation

is designated the length of time after calving during which a cow is milked. During any period of lactation the quality of the milk varies considerably. The variation in percentage composition for the first six or seven months is small, though the size of the fat globules diminishes; but after the lapse of about that length of time, when the quantity yielded generally decreases, the percentage of total solids in the milk shows a corresponding tendency to increase. It is the percentage of fat, however, more than any other constituent which varies.

(*b*) *The length of time between milkings* — It is a quite common observation that the morning's milk is not as good as that from the evening milking. This is not because there is any difference in the quality of the milk secreted by night and by day, but because the interval preceding the morning milking is commonly longer than the day interval. Careful observation shows that the longer the milk is retained in the udder the poorer is its quality. This appears to be due to the fact that there is a tendency to the re-absorption of constituents. If, under otherwise similar conditions, a cow is milked three times daily, with an approximate interval of eight hours between milkings, she will give both more and better milk than if milked twice daily. In several countries of Europe, where the milking is usually done by women, whose labor is cheap, it is customary to milk three times daily.

(*c*) *Nervous excitement and fright* — Any conditions whatsoever tending to excite the cow, such as the unaccustomed presence of dogs, sudden fright from any cause, or irritation of any kind, cause a variation in quality of milk. Hoard has pointed out an extraordinary difference between the quality of the milk of a favorite cow just before and just after a violent scratch with a pin. The conclusion is plain that cows should be milked under conditions as favorable as possible to the comfort and quiet of the animal.

(*d*) *Different portions of the milking* — There is a wide difference between the quality of that portion of the milk first drawn from the udder and the last portions. The percentage of fat in the milk first drawn is sometimes as low as 1, in that of the last as high as 10. Because the milk first drawn is so very low in fat and because important advantages are con-

nected with the practice, some dairymen reject the first few streams milked from each teat.

(*e*) *Unaccounted for variations* — The quality of the milk yielded by any cow tends to vary to some extent from day to day from causes which cannot always be understood. It is known, however, that the weather, the state of the digestion, febrile excitement from any cause, all tend to cause variations. In short, the cow is an exceedingly sensitive animal and only when kept in conditions of perfect health and comfort, and milked with regularity at suitable intervals under conditions as favorable to quiet as possible, does she produce milk of the best quality of which she is capable.

CXXVII — GOOD COWS ESSENTIAL TO PROFITABLE MILK PRODUCTION.

759. *The cost of keeping a poor cow the same as that of keeping a good one* — The fact that there is an enormous difference between the individual cows of almost all herds in respect to the quantity and quality of milk yielded is generally well known. How important an influence on profits the selection only of animals of good individual quality may have is not so well appreciated as it should be. According to the most careful authorities the average butter yield for cows in the United States a few years since amounted to only about 130 pounds yearly per individual. Between this figure and an average of 300 pounds or more which is obtained by good dairymen there is an enormous difference. There are in very many herds of the country individual cows that do not pay for their keeping. "Cow boarders" these have been called, — poor boarders, for they do not pay their bills. The poor cow requires just as much room in the stable, will usually consume practically the same amount of food, and requires about the same amount of care as a good cow. The actual cost of keeping a cow in Massachusetts will vary according to conditions from about $40 to $70. The cow that will yield 6,000 pounds of milk or make 300 pounds of butter will prove profitable, but the cow that gives only 2,000 or 3,000 pounds of milk or makes less than 200 pounds of butter must in the majority of instances prove an unprofitable animal.* Many farmers keep poor cows

* Prof. F. S. Cooley of the Massachusetts Agricultural College says that the value of a milch cow may be obtained by adding to the sum representing her value for beef such sum

simply because their inferiority is not definitely known. One of the first points in the direction of improvement in dairying is the keeping of such records and the making of such tests as will suffice to show just what each individual cow in the herd is doing. With definite knowledge concerning the individuals of his herd the farmer may be depended upon to dispose of the unprofitable cows in short order.

760. *Keep an individual record* — To know what each cow in the herd is doing it is necessary to determine how much milk she gives, what its quality is, and how long she milks. The first step to determine these points is to weigh each cow's milk and to keep a record. An ordinary spring balance with scales marked in pounds and tenths is useful. The records should be kept in a convenient place in the stable, and should be kept clean, as it is disagreeable to work over dirty records. To secure the desired ends the following device is perhaps as good as any. Take a roll of the same circumference as the length of the record paper for one month. Put an arbor in each end. Tack the record paper smoothly to the roll, make a box of such size as to receive the roll, setting the arbors in holes in the ends of the box so that the roll will turn freely. Cut a slot in the top of the box ½ inch wide and have a slat to cover this slot. Write the names of the cows on the box and turn the roll as desired, writing the proper amount for each cow on the proper line, which by turning the roll is brought to the slot in the top of the box. At the end of the month, of course, the record for that month is removed and a new one substituted.

It is of course considerable trouble to weigh the milk of every cow at every milking, and this is possibly unnecessary, although many good dairy-

---

as that on which she will pay 33⅓ per cent. annually above the cost of keeping. The 33⅓ per cent. he arrives at as follows: Interest, 6 per cent.; taxes and insurance, 2⅓ per cent.; depreciation, 25 per cent.—a total of 33⅓ per cent. Depreciation is fixed at 25 per cent., on the supposition that the cow will be worn out in four years. Let us take an example. A cow of such live weight that when fat she will be worth about $25 for beef yields 6,000 pounds of milk per year. This is equivalent to about 2,800 quarts. This, at 3 cents per quart, will be worth $84. The cost of keeping the cow a year is $60. She pays, then, above the cost of keeping, yearly $24. Twenty-four dollars is 33⅓ per cent. of $72. This cow then, on the basis of Professor Cooley's system of valuation, is worth $25 beef value plus $72, or $97.

men do it and believe that it pays. No doubt a fairly accurate idea as to the performance of each cow can be obtained by taking the weight of a few milkings at regular intervals during the year. Care should be taken, however, in comparing different cows, that the yield of milk at equal distances from calving only be compared. Not a few cows giving a large amount of milk at the start rapidly fall off. Persistent milking is one of the most valuable characteristics of a cow. A wholly false idea might be obtained as to the relative value of different cows by comparing their yields when fresh, for it is the cow that holds out, giving a good, fair quantity throughout the year, that proves the most profitable. It is not enough, however, to know how much milk a cow gives. Before an animal can be fairly judged one must know the quality as well as the quantity. The most accurate method of determining the quality of milk is to make a chemical analysis which determines the amount of each constituent, but a chemical analysis is costly and cannot be carried out by the busy farmer. Nor, indeed, for ordinary purposes can it be regarded as essential. The value of milk for most purposes is determined with sufficient accuracy when we know the proportion of butter fat which it contains. This can easily be determined by means of the Babcock test. The Babcock test was perfected by Professor Babcock of Wisconsin, and was given by him to the farmers of the United States. This test is so simple that any intelligent person can readily learn how to carry it out.

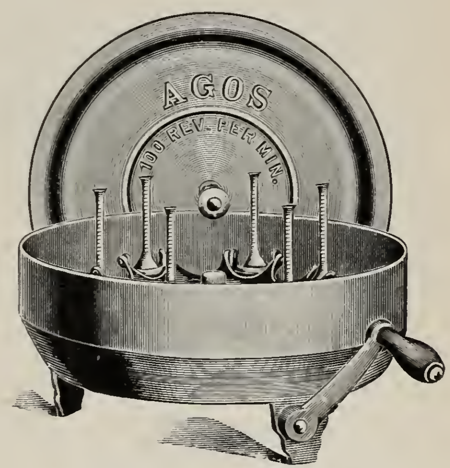


FIG. 234. HAND BABCOCK TESTER AGOS.

761. *The Babcock test — (a) Apparatus needed.* The essentials needed for carrying out the Babcock test are a centrifugal machine revolving at a high speed whereby the bottles containing the milk can be whirled; and a few simple pieces of glassware. These centrifugal machines take the

name of Babcock testers or centrifuges. There are many styles upon the market adapted for work both upon a small and large scale, and operated by all kinds of power. There are a number of beautiful running hand machines with a capacity of from four to twelve bottles. Among power machines those operated by a steam turbine are looked upon with much favor at the present time as they are on many accounts more convenient than belt machines. For the farmer's use the hand tester answers admirably. There is considerable variety in glassware used in connection with the Babcock test. As a rule the simpler and less expensive forms are to be preferred, both from the standpoint of accuracy and expense. Test bottles are needed for both new and skim milk and for cream, and the farmer may need each of these three kinds. In addition he needs a pipette for accurately measuring milk and an accurate measuring glass for acid. Both the forms of testers and the glassware mentioned are shown in the illustrations.

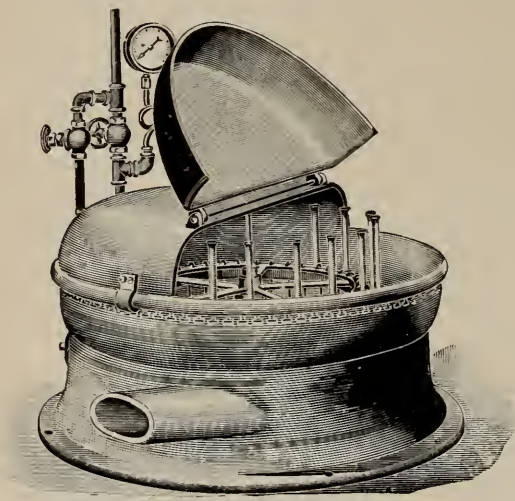


Fig. 235. Steam Turbine Babcock Tester.

762. *Carrying out the test* — (*a*) *Sampling*. It is obvious that correct results depend upon having a good sample, and to take a good sample of any kind of milk or cream is not possible without suitable precautions. The fat globules rise rapidly to the top and unless care is taken the sample will not be fairly representative. In order to get a good sample of milk it must be mixed thoroughly by pouring it from one vessel into another at least three times and better five or six times. Shaking in the bottle or can will not answer. As soon as possible after thorough mixing by pouring, the sample should be taken out by dipping with a small, long handled dipper of

any kind. A special tube known as the "milk thief" is constructed for the purpose of taking samples. It is not, however, commonly necessary to use this. If a sample is to be carried any distance the vessel in which it is carried should be filled absolutely full, for if this is not done some of the butter fat will be churned and a correct test cannot be made. It is of course better to make the test while the milk is sweet; but a well-taken sample even

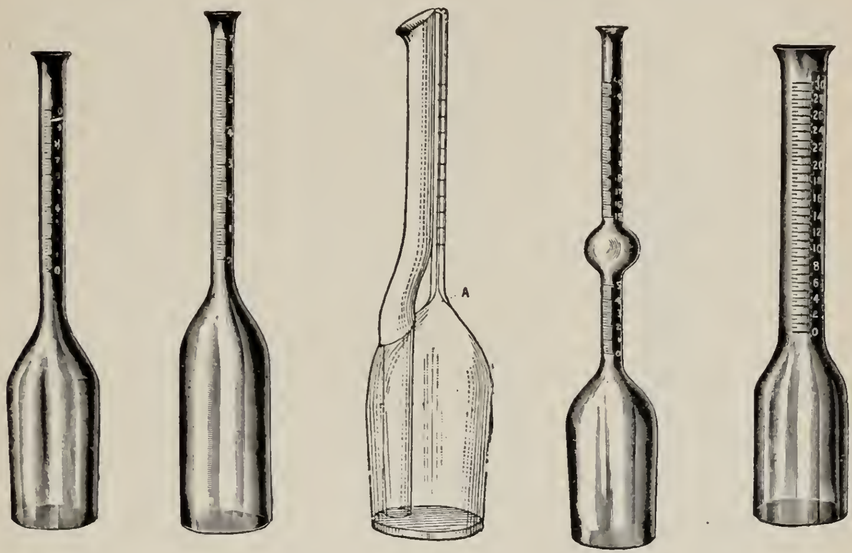


FIG. 236. BABCOCK GLASSWARE.

if soured can be tested with approximate accuracy by adding to it a volume of ammonia water equal to 5 per cent. of the quantity of milk. The reading in the tube on the test bottle must, of course, be increased by 5 per cent.

(*b*) *Measuring the milk* — When the milk is thoroughly mixed, insert the lower end of the milk pipette, into the vessel containing it and, with the mouth applied to the upper end by suction, draw up the milk until it is a little above the mark indicating the correct amount (17.5 *c. c.*). Then place the dry finger over the top of the pipette and by raising it very

slightly let the milk fall to the mark. Then allow the milk to run slowly from the pipette into the test bottle and when all is out that will run gently blow out the pipette as dry as possible. It is well to practice using a pipette somewhat before beginning to test. In testing heavy cream it is better to weigh rather than to measure if exact results are desired.

(*c*) *Adding the acid* — Sulfuric acid with a specific gravity of 1.82 is used in making the Babcock test. Such acid can be purchased of dealers in dairy supplies. After the milk has been placed in the bottles the correct amount of acid (17.5 *c. c.*) should be carefully measured out and poured into the bottle. Great care, however, should be exercised in doing this or the results will be unsatisfactory. The acid should be poured down the sides of the bottle slowly so as not to entirely close the neck of the bottle and also in order not to char the milk. If the acid be incautiously added the casein of the milk is charred or burned instead of being dissolved and appears in the mixture in the form of suspended black flakes or particles. The acid should be mixed with the milk by shaking with a rotary motion. The mixing cannot be overdone and should be very thorough. If the acid has been properly added the mixture of milk and acid becomes perfectly translucent. If a number of tests are to be made at the same time, which is practically invariably the case, it should be remembered that it is best to mix the acid and milk in each bottle as soon as the acid is added. The proper temperature of acid and milk is about 60°. If the acid is too strong it forms what is sometimes spoken of as a black curd. Black curd or flakes are also formed if the milk is too warm. If the acid is not sufficiently strong the casein is imperfectly dissolved and white curd or flakes appear in the mixture.

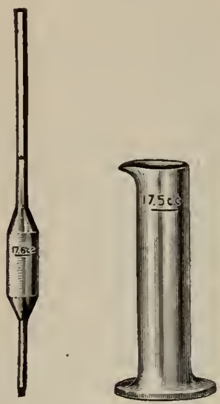


Fig. 237. Pipette for Milk and Acid Measure.

(*d*) *Whirling the bottles* — The bottles must be placed in the tester in such a manner as to balance. The machine must be run in accordance with directions furnished with it, generally from about 700 to 1,200 revolu-

tions per minute, the speed depending in a measure upon the diameter of the machine. The whirling must be continued for five minutes. As soon as the machine comes to a standstill the bottles should be taken out and sufficient hot water added to bring the fluid in the bottles nearly to the top of the graduated part of the neck. Then replace the bottles in the machine and whirl for two minutes. When the machine stops running examine and if the division between the fat and the fluid beneath is not clear whirl again for a minute or so.

(*e*) *Reading the test* — If several tests are to be read the bottles should be placed in a pan of hot water, to keep the fat in a melted condition, for if it becomes cold enough so that it will not run readily serious errors result. The test should be read from the extreme top of the edge of the fat to the extreme bottom, *i. e.*, from the upper edge of the miniscus to the lowest point of the column of fat in the tube. The diagram shows part of the neck of a bottle. The reading should be from *a* to *b*, not *c*. The difference between the lower and the upper reading gives the percentage of fat. The reason for reading in this way is that a small amount of fat is left with the other fluids in the bottle. This is composed of the smaller globules of fat and the amount is practically uniform and has been found to be about equal to what would be required to level the curved surfaces in the neck of the bottle. For reading, a small pair of accurate compasses is useful. Place one point of these at *a* in the figure, the other at *b*, then placing one point at the lowest line in the scale the other point will stand at the line which indicates the percentage of fat.

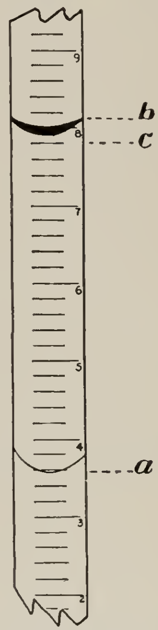


FIG. 238. DIAGRAM OF PART OF NECK, BABCOCK TEST BOTTLE. FAT COLUMN COVERS SPACE BETWEEN THE CURVED LINES. READ FROM *a* TO *b*, NOT *a* TO *c*.

(*f*) *Cleansing the glassware* — Good results in making the Babcock test cannot be secured unless all glassware used is kept clean. This is easily

done with very little trouble. As soon as the reading is finished, and while the contents are still hot, the bottles should be emptied and then rinsed twice, first with warm and then with hot water containing either alkali, washing soda or any of the various washing powders, and then finally rinsed with either warm or cold water until they are perfectly clean. The milk pipette should be washed in a similar way and the acid measure should be rinsed and placed upside down.

763. *Testing individual cows* — As has been pointed out (758) the quality of the milk yielded by any cow is subject to variation through numerous causes. It will be understood, therefore, that the test of the product of a single milking may not afford an accurate idea as to the quality of the milk yielded by a cow. Far better than the test of a single milking is a test of the mixed milk from a number of successive milkings. Such tests are commonly known as composite tests. In order to make a composite test for the cows of a herd a separate jar must be provided for each cow. A common pint fruit jar will answer. At each milking pour the milk back and forth as has been directed, take a small sample and put into the jar. For safety, even if the weather is cool, and necessarily at other times, a preservative must be used. Bichromate of potash answers the purpose. The quantity which can be taken up in a .22-inch caliber shell cut one-half inch long is enough to preserve one-half pint of milk for a week. Each time fresh milk is added to the contents of the jar it will be well to shake. A sample of the product of each milking for three or four days will be approximately accurate and the quantity taken out each time should be so gauged that the total amount in the three or four days will be about one-half pint.

To calculate the yearly yield of butter fat with the utmost accuracy it is desirable, on account of the variation in the quality of milk during the period of lactation, to make a number of tests of composite samples during the year. If it be desired, however, to reduce work of this kind to a minimum and at the same time secure fairly accurate results, it will be best to take one composite sample sometime between about the sixth and twelfth week after calving and another about six or seven months after calving. The average of

these two will fairly represent the quality of the milk given by a cow throughout the year providing care is taken that the animal is in perfect health and that all the conditions are normal at the time the samples are taken.

764. *Testing an entire herd* — It sometimes happens that a farmer selling milk desires to know the average composition of the mixed milk of the herd in order perhaps to see if it is up to legal standard. The best method of determining this is to mix the milk of the entire herd in a churn, or in any other convenient way, and then take a sample, but where the quantity of milk produced is large this is hardly practicable. If a sample of each cow's milk, which shall bear to the other samples the same proportion that the total milk of the cow bears to the total milk of the other cows, be taken, then these mixed samples will fairly represent the milk of the herd. Where a sample of this kind is wanted the "milk thief," whereby a column of milk the entire depth of the contents of the pail can be taken for each cow, will be needed. It will, of course, be understood that the small samples so taken must be thoroughly mixed and from the mixture the final sample needed for the test taken in the usual way.

The average for a herd can be calculated from individual tests for a month or year by percentages but such calculation would not be accurate unless the varying quantities of milk yielded by the different cows be taken into account, and to make the calculation in this way, giving due weight to the figure for each cow, would make a somewhat complicated and lengthy problem.

CXXVIII — CONDITIONS ESSENTIAL FOR THE PRODUCTION OF GOOD MILK.

765. *The cow must be healthy* — Any condition which injures or impairs the health of the cow will to a greater or less extent affect the quantity or quality of the milk that she produces. It is of prime importance then at the start to secure thoroughly healthy cows. Not alone is the milk of a cow affected with certain diseases poor in quality, it is unfit for human food on account of the possibility that the disease from which the cow suffers may be transmitted to the person consuming the milk. The only disease which is sufficiently common to make this consideration of much importance

is tuberculosis. It is doubtless true that the milk from cows in the early stages of tuberculosis has often been consumed by individuals without apparent ill consequences. Indeed there is considerable evidence that unless the tubercular disease affects the udder itself or has made serious inroads upon the general health or condition of the animal the milk may be safely consumed. Nevertheless no well-disposed person can contemplate with satisfaction the possibility that the milk he furnishes may carry with it a disease which is likely to be so serious in its consequences. Every milk producer, then, should endeavor to keep for milk production only cows which are free from tuberculosis. This is now entirely possible. The tuberculin test is a safe and sure means of determining whether animals are affected by this disease, and every milk producer owes it *to the public*, *to his family*, *to himself*, to keep his herd free from this scourge. In all cases at least where there is any reason to suppose that tuberculosis exists, and in all cases where it has been found, it is best that all the animals of the herd be subjected to the tuberculin test once in about one or two years ; and when a herd has once been freed from this disease no farmer should put into it any except cows which have successfully passed the tuberculin test. Starting with cows in good health, however, is not enough. They must be kept under conditions favorable to the maintenance of such health. Cows are often kept under conditions such that it is a miracle that there is a healthy animal in the herd. The most frequent errors in providing for cows are insufficient air space, poor ventilation, providing too little light, and an unsanitary system of caring for manure.

(*a*) *Air space and ventilation* — It is now generally admitted that it is desirable that the stable should be of such size and height as to allow not less than about 1,000 cubic feet of air to each cow. The amount of air space necessary, however, depends in a measure upon the provision made for ventilation. No amount of air space can compensate for total absence of ventilation. In the best modern stables the cows are kept in separate wings without manure underneath and without forage stored overhead. One of the commonest types of construction is the Monitor roof wing entirely open from the floor to the roof. If such a stable has only such

width as is required for two rows of cows facing each other, which is a common and the best type, it can be sufficiently well ventilated by means of windows on the two sides both overhead in the monitor and below. The windows should swing in from the top, and if triangular sideboards are attached in such a way as to close the space left on each side of the window as it swings inward, direct currents of air upon the animals are prevented and the results are satisfactory in every way. A window thus equipped is now often spoken of as the Sherringham valve. It is a matter of great convenience if such fixtures, slightly modified from those in common use in hothouses, can be put up as will make it possible to move all the windows on one side in the monitor at one time and from the floor below. Cupolas in the roof are also valuable assistants in promoting ventilation.

FIG. 239. BARN AND COW STABLE, MASSACHUSETTS AGRICULTURAL COLLEGE.

(*b*) *Good light* — A surprisingly large proportion of our cow stables are badly lighted. Sunlight is the best germicide known. Every stable should be so constructed that the light reaches all parts of it. Abundant sunlight in the stable will prove a controlling factor in maintaining good health in the herd.

(*c*) *The interior of the stable* — The interior of the cow stable should be as open and free from obstructions as possible. Not only is this essential so that the light may reach all parts, but it greatly facilitates cleanliness. The number of comparatively inaccessible angles and confined spaces should

be reduced as far as possible. The interior finish should be as hard and smooth as may be in order that it may be readily kept clean. Mangers and ties are of innumerable forms and into the details of construction space will not allow us to go. The manger should be simple, "get-at-able," and the tie such as to allow the animal to stand or lie in comfort.

FIG. 240. INTERIOR OF COW STABLE, MASSACHUSETTS AGRICULTURAL COLLEGE.
This stable accommodates 65 cows; dimensions, 135 x 42 feet. Food and water both given in manger.

CXXIX — MEANS WHEREBY MILK IS CONTAMINATED AFTER LEAVING THE COW.

766. *Chief methods of contamination* — Milk as it leaves the udder of the healthy cow is practically pure, free from germs and foreign matter. It may become impure or tainted in various ways: —

1st. By mixture with it of particles of dirt, manure, bedding, hair, etc., during or after milking.

2d. By absorbing strong odors as from manures, fertilizers, silage, brewers' grains, etc.

3d. By introduction of bacteria, which may cause souring, or bitter, slimy, ropy, or so-called "bloody" milk.

767. *Contamination with dirt, manures, etc.* — Milk is contaminated

with filth of various kinds in many cases through carelessness in the barn. There are likely to be particles of dust and dirt in the air and on the bodies of most cows, especially about the udder. All of these are likely to fall into the milk chiefly during milking. The attempt to prevent this by attaching a strainer to the milk pail during milking is not advisable. Such strainers are cumbersome, they tend to spatter the milk and are disagreeable to use. The true method of preventing contamination of milk by such foreign matters as we have under consideration is to be sought in securing the right conditions in the stable, thoroughly cleansing the cow and by the employment of milkers clean in person and clothing who understand how the cow should be milked and who will do the work properly.

(*a*) *In the first place the stable should be thoroughly clean* — If it is swept this is done some time before milking in order that all dust may have had time to settle. Fodders, especially those that are dry, should not be handled in the stable either just before or during milking for dust from such fodders is a prolific source of contamination.

(*b*) *The cow should be made thoroughly clean* — The whole body should be brushed and the udder and parts of the body adjacent to the udder should not only be brushed but wiped with a damp cloth or sponge. Dampening the hair just before milking will do much to prevent dust from the udder and parts adjacent falling into the pail.

(*c*) *The milker should in person be scrupulously neat and clean* — He should wear a special suit of clothing used for milking and for nothing else and always kept clean. Many of our best milk producers provide a dressing room for the use of their milkers and require them to wear clean, white suits.

(*d*) *Milking should be done gently, quietly, and rapidly* — The first two or three streams milked are discarded by many, as they contain very little butter fat and are liable to carry into the milk large numbers of bacteria, which multiply about the orifice in the end of the teat. Should these bacteria be carried into the milk its keeping quality is impaired. The milker should do his work with dry hands. If the hands could be simply moistened the practice would be allowable, but the practice of moistening the hands is apt to degenerate into the habit of making the hands wet, so wet that there

is a drip from the hands into the pail. Such drip invariably means filth and accordingly most milk producers insist that milking shall be done with dry hands. Many efforts have been made to perfect a machine for milking, but while some machines appear to do the work fairly well the general experience is that the yield falls off more rapidly when cows are milked by machine than if the work be done by hand, and this single feature involves a loss more than enough to balance any possible saving in the cost of milking.

FIG. 241. MILKERS READY FOR WORK AT LARGE DAIRY FARM IN NEW JERSEY.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. Agriculture.

(*e*) *Milk should be removed from the stable immediately after it is drawn* — Milk while cooling absorbs odors with great rapidity. While the aim should be to keep the stable free from odors this result can seldom be so perfectly attained as to make it desirable that the milk should stand in a stable.

(*f*) *Straining the milk* — Milk should be strained as quickly as possible

after it is drawn. Many methods of straining are in use. For ordinary purposes the common wire and cloth strainers appear to be most desirable. Where the milk is to be used for the supply of fastidious customers more careful straining is advisable and the milk may be passed through a number of wire and cloth strainers successively. In some cases, especially if the cows are bedded with any fine material, like dry earth, or peat, a layer of cotton between two cloth strainers does excellent work. Cloth strainers may, of course, be washed and repeatedly used. No attempt should be made to cleanse cotton. A fresh sheet should be taken each time. Where several milkers are employed it has been found an incentive to clean milking to use individual strainers. These strainers are numbered and each milker is assigned a number, the number always being the same. One can then tell at a glance just the quality of work that the different milkers are doing. Under this system milkers soon come to take a pride in having their strainers clean. If a man is found who does not do this he is not a desirable man to keep in the stable. While straining helps to remove certain impurities from milk it should always be kept in mind that it is far better to adopt such a system as will keep the milk clean than to try and strain it clean after it has been fouled.

768. *Contamination by odors* — In other connections a number of hints connected with this topic have been given. The milk producer, however, should never forget that milk freshly drawn from a healthy cow is rarely tainted with odors. If it is found to have a disagreeable odor and flavor, investigation will commonly disclose the fact that it has absorbed such odor from its surroundings. Warm milk absorbs odors with great rapidity. The stable, then, must be kept as free from odors as possible. To this end, as well as for the health of the animal, ventilation is essential. If, after spending some time in a stable, a decided so-called "stable odor" clings to the clothing it is evidence that the stable is insufficiently ventilated or improperly cleansed. Certain foods, whether preserved or handled in a stable during milking or where milk is straining, have been named. It is best that foods of such kinds as cabbage leaves, turnips, silage, and wet brewers' grains should never be stored in a stable itself but in an adjoining room,

and there should be some means of ventilating the space leading from the part of the barn or the silo where such fodders are stored, to the stable. It seems almost superfluous to add that materials such as onions, fertilizers, etc., should never be stored in a stable, and yet such things are sometimes done.

769. *Contamination by means of bacteria* — Milk as it is secreted by the healthy cow is believed to be sterile, *i. e.*, it contains no germs. So far as it is known it is not possible for bacteria of any kind to pass through the digestive organs and the blood vessels and appear in the milk. True, typhoid fever (and occasionally other diseases) is sometimes traced to the milk supply. In most cases, however, it is not believed that the germ of typhoid fever passes through the body of the cow. It is almost invariably found that their presence in the milk is due to the use of water containing these germs in washing the vessels containing the milk. The milker also may carry disease germs to the milk, such, for example, as those of diphtheria, tuberculosis, and typhoid fever. No person known to have a contagious disease should be allowed to milk or to handle the milk.

If the udder of a cow, however, is the seat of disease, due to the presence of bacteria, then some of these bacteria may appear in the milk (tuberculosis). The end of the teat of the cow is, however, usually moist and its temperature is favorable to the multiplication of bacteria. Bacteria are practically everywhere and some are sure to find lodgment from the dust of the air or from contact with bedding, manure, etc., in the ends of the teats. Multiplying there bacteria sometimes work up into the teat and into the larger milk ducts of the udder. It is because of the probability that the very first drawn milk (which comes from the teats and the larger milk ducts) will contain bacteria, that it has been suggested that the first few streams be discarded (766, *d*). It is practically impossible to milk a cow under such conditions that no bacteria will find their way into the milk. The air of the stable, the hair of the udder of the cow, in fact all the surroundings of the barn are charged with bacteria. These find a fertile and congenial medium for growth and multiplication in the warm milk as it is drawn from the cow. While absolute freedom from bacteria is an impos-

sibility, the number can be kept relatively low by observing the conditions of cleanliness, ventilation, etc., which have been alluded to in other connections. It has been found that when cows are milked in the open air amid clean surroundings the milk is much freer from bacteria than when they are milked in the stables. If the latter, however, can be kept scrupulously clean the number of bacteria can be kept sufficiently low for all practical purposes. Milk pails and dairy utensils of various kinds are often the source from which bacteria find their way into milk. Having been used to hold milk in which bacteria have multiplied and then being imperfectly cleansed they seed the new milk put into them abundantly with bacteria of various kinds. All dairy utensils should be smooth, especially in the interior. They should be made of non-absorptive materials. If made of tin the seams should be perfectly filled with solder. However well made, without attention to suitable cleansing, milk cans, bottles, etc., will be sure to prove a source of contamination. Every dairy should have a plentiful supply of hot and cold water, and, if possible, steam ; and soap and washing soda or washing powders should be freely employed. All tinware used in handling milk or cream should be first rinsed in warm water, then thoroughly washed in hot water and strong soap or washing soda, then rinsed and finally scalded or steamed for several minutes. Simply turning live steam into a can, pail, or bottle is not all that is necessary. The steam needs time to reach every crevice and corner. Cloths and sponges should be used as little as possible in washing dairy utensils. Brushes are better.

770. *Kinds of bacteria in milk* — Almost all kinds of bacteria may live and grow in milk, but under normal conditions the number of species found in milk is small. The greater part of the bacteria in milk are of kinds which cause changes in some of its constituents, generally known as fermentation. Accordingly some of the leading kinds of bacteria found in milk are known as ferments. Besides the bacteria which cause fermentation, milk may contain the bacteria of any germ disease. The normal fermentations of milk are of three classes. We have, first, bacteria which feed upon and cause the change of the milk sugar into lactic acid, — lactic

ferment ; second, we find bacteria which feed upon and change the albuminoids of milk, of which there are two kinds, one kind causing fermentation favorable to digestion, the other kind forming products which result in the development of exceedingly disagreeable odors and flavors ; we have, third, bacteria which attack the fats. These cause the particularly disagreeable odor and flavor of rancid butter. These are the butyric ferments. Many other abnormal fermentations occasionally occur in milk, each of which is due to the action of specific ferments. As a result of the action of one, milk coagulates without becoming sour and what is called sweet curd is formed. The action of another results in the formation of an intensely bitter milk. The action of others cause milk to become ropy or slimy, and there are still others as the result of whose activities unnatural colors are produced. One of the most frequently noticed is a red color which gives the milk the appearance of being bloody.

771. *Relation of bacteria found in milk to the human system* — The greater number of the bacteria found in milk are harmless and may be taken into the stomach in large numbers with impunity. The germs which are connected with disease are of course exceptions. None of the germs found in normal milk are actually harmful. They may give the milk an unpleasant taste, but they are otherwise harmless. Under abnormal conditions milk may be contaminated with germs whose development in it causes the formation of poisonous products known as ptomaines. The fatal results from the consumption of milk, ice cream, and cheese are generally due to the presence of ptomaines. Fortunately the germs whose activities result in the formation of ptomaines are comparatively seldom present. As a rule the different fermentations which occur in milk do not go on at the same time. The growth and development of bacteria of one sort in most instances serve to retard the development of others.

772. *Control of fermentation in milk* — Undesirable fermentations in milk can be largely prevented by the adoption of suitable measures, among which the following are the most important : —

1st. *Prevention of infection* — This depends upon absolute cleanliness and has been made clear.

2d. *Holding the milk at low temperature* — Only when the milk is warm do bacteria of different kinds develop rapidly. If milk can be immediately cooled to about 40° F., very little fermentation of any kind will go on in it. It will keep sweet for a considerable length of time. In some cases, however, milk acquires a disagreeable flavor — not sour — after three or four days, because of the activity of germs, which develop slowly at low temperatures. Milk sufficiently good for all practical purposes and milk which will keep as long as is usually required can be secured if, in the first place, bacteria are excluded as far as possible, and, second, if the milk be cooled and kept cold.

773. *Destruction of germs in milk* — Numerous substances are known which have the property of destroying the vitality of both bacteria and their spores and not infrequently, it is to be feared, some of these substances are added to milk for the purpose of increasing its keeping qualities. All the substances now known which have this property, although not in all cases active poisons, exercise an injurious influence if steadily taken in such quantities as would be found in milk preserved by them. Formalin, salicylic acid, and boracic acid are among the least injurious of these substances, but their use for the preservation of milk cannot be recommended under any circumstances. It has been thought that electricity might be used to destroy the vitality of the germs in milk without injuring its quality, but no successful method of employing it is yet known. In order absolutely to destroy both active bacteria and spores it is necessary to hold milk at the temperature of 212 to 224° F., for one hour on three successive days. Holding it at the temperature of from 175 to 212°, as above indicated, kills all actively-growing germs but does not kill spores. If, however, milk be subjected even to the lower temperature named it acquires a cooked flavor and is less desirable for use than milk which has not been so heated. It has been found possible to destroy all disease germs likely to be found in milk, as well as those germs which cause ordinary fermentations, at considerably lower temperatures,— temperatures so low that the flavor of the milk is but little changed. This method is known as Pasteurization, the name being taken from Pasteur, the great French bacteriologist. Pasteurization is of

such importance that it will be considered and described at length in connection with the general subject of market milk and cream.

CXXX — DISPOSAL OF DAIRY PRODUCTS.

774. *General considerations* — Dairy products may be sold in various ways, most common among which are in the form of milk, cream, butter, or cheese. Occasionally a farmer well located manufactures ice cream and finds that branch of business profitable. The skim milk may sometimes be worked up into cottage or other cheese; the sugar is extracted from whey or skim milk and put upon the market, there being considerable demand for it. From the skim milk albumin is sometimes separated, this being employed as a substitute for eggs in cooking as well as for other purposes. What method of disposing of the products will prove the most profitable depends upon many conditions, such as distance from market, character of the market, kind of cows, the nature of the farm, and the taste of the individual. Among the various methods of disposing of the product of the cow the marketing of milk and cream, as was stated in our introduction, is the one likely to be most generally profitable in the older states.

CXXXI — MILK AND CREAM FOR THE MARKET.

775. *The kind of milk wanted* — In most cities and towns of the older states competition is so severe between the producers of the cheaper grades of milk and cream that the margin for profit is small. There is, however, in most places of considerable size a large demand for strictly first-class goods at remunerative prices. To produce first-class milk and cream requires careful attention to many details. Those connected with the production of sound milk to start with have been discussed at length. The methods of treating and handling milk and cream produced in accordance with the rules which have been laid down have now to be considered.

776. *Cooling and aeration* — The advantages connected with rapidly cooling milk have been pointed out. Milk may be cooled in many simple ways without at the same time aerating it, but where the quantity of milk is large the use of the combined cooler and aerator is to be recommended,

first, because the milk can be more rapidly cooled than by any system of plunging in water, and, second, because the exposure of the milk to the air helps to free it from odors, usually collectively spoken of as animal odors, which are due to the presence of gases dissolved in the milk and which are disagreeable to many. The amount of animal odor depends largely upon the condition of the animal at the time the milk is drawn. Sometimes it is very slight and scarcely noticeable, at other times it is so great as to be exceedingly offensive. Milk which has been aerated, whether the amount of the odor is large or small, will be more certain to suit the taste of consumers than that which has not been so treated. Many forms of aerators and of combined aerators and coolers are made. The combined form is the one almost invariably used. It should be light, convenient in size, and of such construction as to be readily cleansed. The Star combined aerator and cooler (of which a cut is shown) is one of the most satisfactory. In this the milk first strained into the receiver passes into the shallow trough at the top of the aerator proper and then flows in a thin stream over the corrugated surfaces to the trough at the bottom, from which it runs into a vessel set to receive it. The Star aerator and cooler is double and cold water or cold brine is kept continually flowing through it. The number of degrees that the milk can be cooled by the use of this aerator depends upon the comparative amounts of milk and water used and their respective temperatures. It is easy by the use of ice water in sufficient amounts to bring the milk down to 40° F., while by the use of cold brine in large quantities it can be brought to a still lower temperature. There are a number of cheaper coolers and aerators on the market which do fairly good work. Among these the Champion represents one of the most common types.

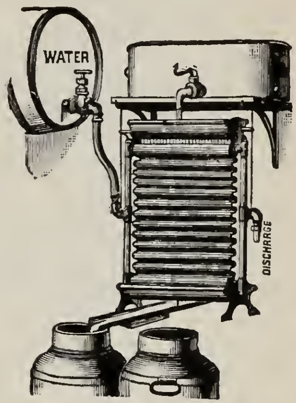


FIG. 242. STAR MILK COOLER.

Where milk is to be prepared for consumers demanding a high-class product some form of cooler and aerator should always be employed. This

in many cases is so set up that the milk passes from the aerator directly to a bottling machine and is rapidly filled into glass bottles, which are at once closed. If handled in this manner and held at low temperature the milk reaches the consumer in a very perfect condition. When milk is being produced for wholesale trade the cheapest and most economical method of cooling is to strain directly into shipping cans and place in ice water or cool spring

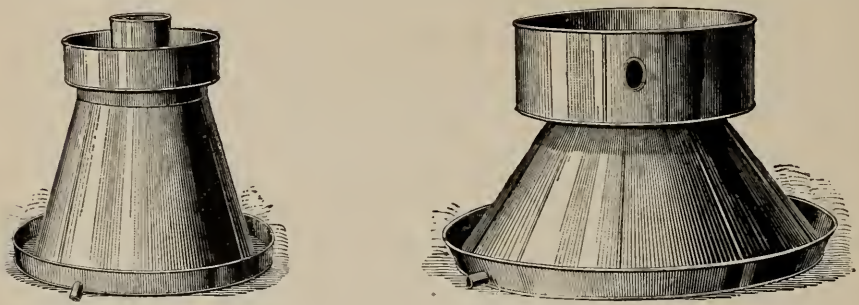


FIG. 243. CHAMPION CREAM COOLER.

water. This is a saving in labor but is not to be recommended where quality is the chief object. It should not be forgotten that such cans should remain open until the milk is thoroughly cold. It is impossible to ship milk from which the animal heat has not been removed and have it arrive in good merchantable condition.

777. *Mixing the milk of the herd* — In order to furnish to all customers milk of the same quality, or to be sure without great trouble of delivering milk of a uniform quality to any given customer from day to day, it is best that the milk of all the cows of the herd, or at least of a large number of cows, be mixed. Where the milk is passed over a cooler or aerator this is usually easily accomplished in connection with that operation, but if milk is to be cooled by setting cans containing it in water it is necessary to take the precaution to pour a number of these cans together before finally putting into cans or bottles for delivery.

778. *The separator as a means of purifying milk* — Some of the most careful milk producers catering to a high-class trade now pass milk which is to be delivered to their customers through a separator for the purpose of

freeing it from impurities of certain kinds which are always to be found in it, even when the milk produced is handled under the best possible conditions. Nearly all forms of dirt found in milk are heavier than the skim milk, and they tend to collect on the outside of the separator bowl and remain there in the form of bowl-slime. Bowl-slime contains a large proportion of the bacteria found in the original milk together with some portions of the albumin, fibrin, and possibly casein. If there be any blood in the milk due to possible injury to the udder or teats, even though it is not enough to be perceptible in the whole milk, it will be taken out by the the separator. Although the separator removes a large proportion of the bacteria it cannot be depended upon as a means of freeing milk from germs dangerous to the human system. Special forms of separators are now offered in the market for use in purifying milk. These may be very useful in the manner indicated for large producers, who aim to furnish the very best milk possible and who can obtain a high price for such an article. There is one objection to the use of the separator for the purpose of purifying milk, viz., it is apt to cause it to foam, and this makes it more difficult to bottle. With the special forms made especially for this use this difficulty is to some extent obviated.

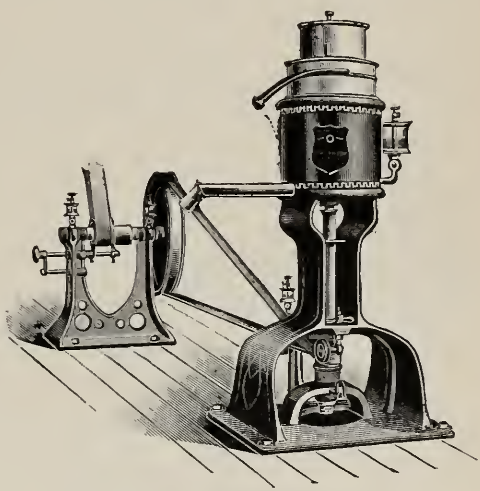


FIG. 244. U. S. CREAM SEPARATOR.

779. *Cans or bottles for milk — which for retail trade?* — For delivering milk to consumers two methods are in common use: First, by the use of cans from which the milk is poured for each customer into some receptacle furnished by the customer; second, by means of glass bottles or jars usually owned by the seller.

The advantages of the first system are cheapness and durability of the cans, less weight as compared with bottles, and less space occupied in the delivery wagon. When cans are used there is no trouble in keeping track of them, whereas with bottles there is likely to be considerable trouble. The chief objections to the use of cans are that it is difficult to keep the milk evenly mixed in the can and therefore impossible to furnish each customer with milk even in quality. Second, one must almost of necessity give somewhat over measure, or at least such is practically the invariable tendency. Third, the system is more or less unsanitary, because in pouring the milk from cans in the frequently dusty air of the town or city street it becomes more or less contaminated. Fourth, it takes longer to deliver to a given number of customers.

The advantages of the system of using bottles are: —

1st. It is easy to furnish each customer exact measure.

2d. The milk having been thoroughly mixed when bottled each customer receives an article of the same quality.

3d. The quality of the milk can be easily seen by the customer.

4th. Milk can be delivered in less time.

5th. It is not exposed to sources of contamination provided the bottles are closed as they should be.

The disadvantages connected with the bottle system are: —

1st. The original cost of the bottles is greater than that of the cans.

2d. There is inevitably a considerable loss of bottles from breakage and other causes.

3d. Bottles weigh more than cans.

4th. It costs more to bottle milk than to put it into cans.

5th. Though this seems comparatively unimportant, there may be danger to consumers of milk from glass poisoning due to the possible presence of little fragments of glass broken from the edge of the bottle in washing or handling.

Practical milkmen have found that it costs from one-half to a cent per quart more to deliver milk in bottles than to deliver it from cans. Many customers, however, demand bottles and for high-class trade it is necessary

and best to use them. Almost every milk dealer, however, will find some customers who prefer tin to glass, on account of the overrun in quantity which they buy or because poisoning from particles of glass is feared. Milk delivered in glass presents a much more attractive appearance than that delivered from cans and the use of bottles has increased in a marked degree within the past few years. In order that the milk so delivered shall present a good appearance the bottles, however, must be thoroughly washed outside as well as inside. They must shine and not present the dull appearance so often noticed.

780. *The best kind of bottles* — At the present time the style of bottle known as the "Common Sense" is almost invariably used. These bottles are closed by means of a pulp or paper cap. There are several forms of these caps, but the common round form held in place in a little groove in the top of the bottle is the most popular. Not a few of the bottles manufactured for the use of milk dealers a few years since were found not to be exact in size. In many instances they held less than the quantity of milk they were supposed to hold. This fact has led to the enaction of laws in many states, Massachusetts among the number, requiring dealers to use in delivering milk only bottles which have been examined and found to contain the right quantities.

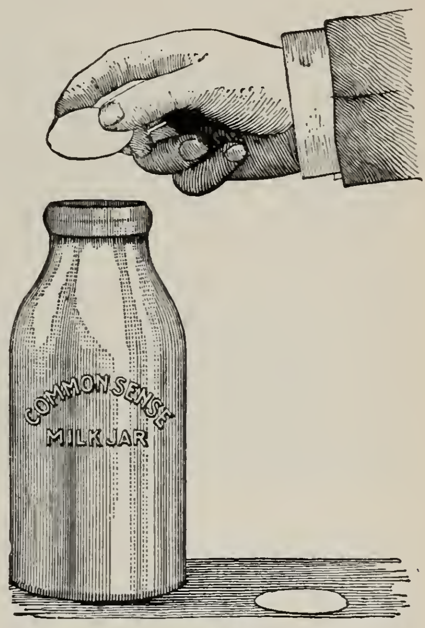


Fig. 245. Common Sense Milk Jar or Bottle.

To prevent losses by means of theft, the name of the dealer or of the farm where the milk is produced should be blown in the bottle. This not only tends to prevent theft but will also prevent the use of the bottles to any great extent by unscrupulous competitive milk dealers. Where bottles are

used for delivering milk a special basket or wire carrier is needed for distributing them to customers. These should be very light but at the same time strong.

781. *Milk bottlers* — Where large quantities of milk are to be bottled some form of apparatus whereby the work can be more rapidly done than would be possible by ordinary hand methods must be employed. There are several patent bottlers upon the market. Among these Childs is probably most largely used in the Northeastern states. This is made in different sizes. One of the most convenient sizes fills at one operation 8 bottles which are placed in a row. The platform containing the bottles will hold 20 rows, making 160 bottles in all. It has recently been found as the result

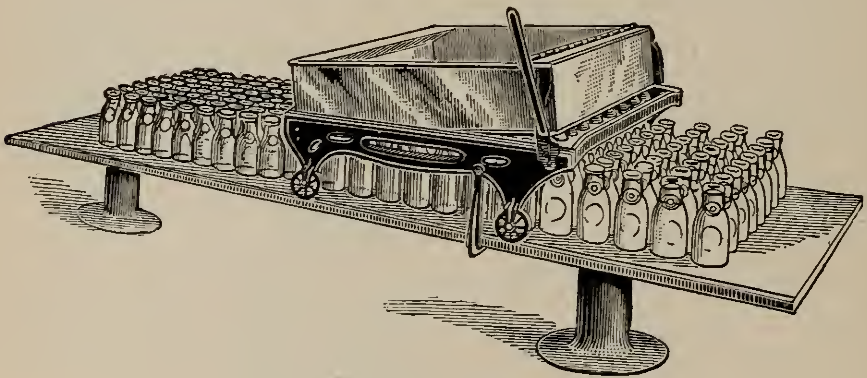


Fig. 246. Childs' Bottle Filler.

of bacteriological examination of milk that the use of a bottler of the type of the Childs very greatly increases the number of the bacteria. It appears to be impossible to so cleanse and sterilize the rubber tubes through which the milk passes as to avoid this. Such tubes cannot be subjected to the high temperatures essential to destroy bacteria without at the same time destroying the rubber. This objection appears to hold with almost equal force against other bottlers and a thoroughly satisfactory bottling machine, as far as the writer knows, is yet to be produced. There is yet another objection which holds against all forms of bottling machines that the writer has seen, viz., the bottles are not equally filled. Some will begin to run

over before all in the row are full, and since to allow the milk to run over the outside of the bottle is very undesirable the flow of milk to all the bottles in the row must be stopped when the first bottles are full and the rest must later be gone over in order to finish filling. Bottles can be quite rapidly filled by means of a can with a spout like a coffeepot. This is perhaps the best way where the quantity of milk is small and it will be free from the objection above mentioned.

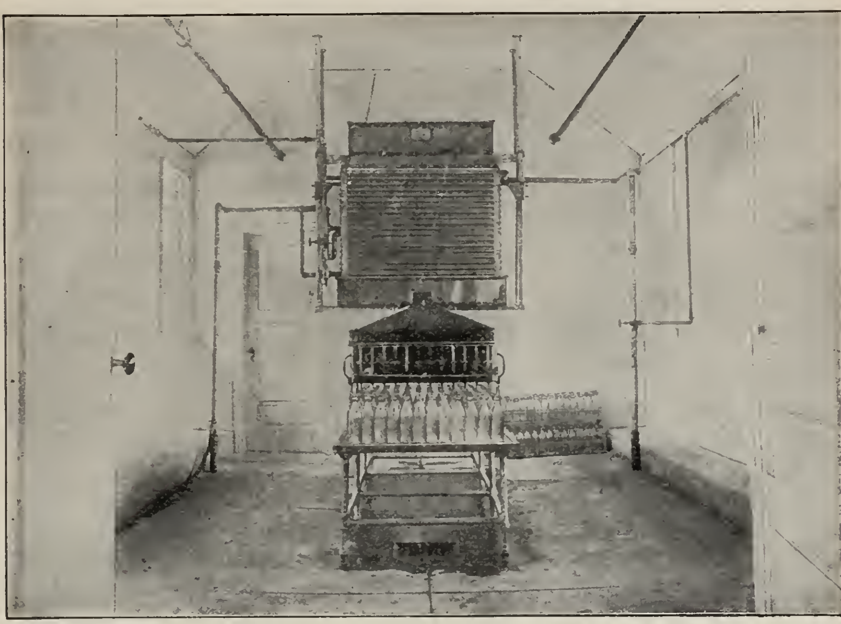


FIG. 247. COOLING AND BOTTLING ROOM.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. of Agriculture.

782. *The milk wagon should be as good as can be bought* — It is subject to continuous hard service and a cheap wagon is likely to prove a source of great expense and inconvenience as it is continually needing repairs. The low-down wagon is the best form. The style is comparatively immaterial. Construction, lightness in weight and draft, convenience and inside space and appearance are the essential things to be considered. The "short turn" or "cut under" styles are convenient, as in narrow streets they save

a great deal of time in the course of a year. If milk is to be delivered in bottles the bottles must be packed in special boxes or crates with a separate compartment for each bottle. Crates which hold a dozen quarts or two dozen pints are most convenient. They should be light and strong. The partitions dividing the boxes into separate compartments should be removable so that all parts can be easily and thoroughly cleaned. Metal boxes for this use are offered in the markets.

783. *How to keep the milk accounts* — Many systems, more or less satisfactory, have been devised for keeping milk accounts. Something that is simple and accurate and which does not take much time is required. With a strictly first-class trade the simplest method is to use a day book showing the amount of milk delivered each day to each customer. A bill is then rendered at the end of the month. By this system it is usually possible to collect about 90 per cent. of the bills during the first three days of the following month at the same time that the milk is delivered. About 98 per cent. of the bills are usually paid by the 25th of the month, when a duplicate bill should be sent to such customers as have not yet paid. This method does away with tickets and making change all through the month. The bills reach the customer when he is most likely to have money to pay them. For the general trade the coupon ticket system is satisfactory. The old style of a separate milk ticket for each quart or pint of milk, these tickets being passed from one to another and carried round in the pocket of the milkman, is entirely unsatisfactory. Such tickets are splendid carriers of disease germs such as those of scarlet fever, diphtheria, etc. The system of keeping accounts adopted by the Springfield Co-operative Association of Springfield, Massachusetts, appears to have much to recommend it. Only one record book is used. This shows the amount of milk and tickets sold, cash received, tickets returned, bottles left, and bottles returned. A portion of the page with rulings and headings for accounts according to this system is shown below. It will be noticed that the days of the month run across the page, the names of the customers down the page. In the account book itself two open pages facing each other provide space for one month's account with about thirty customers. The space for each customer's daily

No.______ Date________________190___
Mr. ______________________________ Route No.______

To Tickets $1.00 MILK Cr.______________

C. P. M. Co. MILK Route No.______
No. ______ Date________________190___
REPORT ANY DISSATISFACTION AT ONCE
PLEASE RETAIN THIS BILL.

Mr. ______________________________

To **HICKORY DELL DAIRY,** Dr.

Certified Milk and Cream. **AMHERST, MASS.**

To Tickets $1.00 Received payment______________
See that this bill is receipted. Date ______________190___

One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint	One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint
One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint	One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint
One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint	One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint
One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint	One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint
One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint	One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint
One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint	One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint
One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint	One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint
One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint	One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint
One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint	One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint
One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint	One Pint	Hickory Dell Dairy **ONE QUART MILK** Amherst, Mass.	One Pint

entry, it will be seen, is divided into four squares. The upper left hand space is for tickets sold, entered in dollars and fractions preceded by the dollars sign: thus, \$1, \$½, \$¼. Payments for tickets are entered in the upper right hand square in decimals, 1.00, .50, .25, etc., entry being made when tickets are paid for. Milk sold, if charged, is also entered in the upper right hand corner. It can seldom happen that both of the kinds of entries which go into this square must be made on the same day. Milk sold for cash is entered in the lower right hand square, and, if sold on tickets, in the lower left hand square. All entries designating quarts of milk are made in quarts and fractions: thus, 3, 3^2, ½, etc. The man delivering milk on his return from a trip settles with the bookkeeper in

Month of............

Name	1		2		3		4		5		6			Total
	\$1					1.00								
John Smith	1^2		1^2		1									
			\$½											
Peter Jones		3		2	2^2									
		2^2		2		3								
Charles Hall														

tickets, cash, and credit for all the milk used daily, while by adding across the page the monthly account with each customer is made up. To make the use of the system perfectly clear, a few entries have been made. Against the name John Smith, under date July 1st, stands \$1. This designates that on that date he had one dollar's worth of tickets. In the upper right hand corner for the 3d of the month stands 1.00 written decimally. This indicates that he paid for the tickets on that date. Two entries in the lower left hand corner for July 1st and 2d indicate that he had on each of those days one and one-half quarts of milk on tickets, and on the 3d, one quart on tickets. Against Peter Jones under July 1st stands 3 in the lower right hand square. This indicates that Peter Jones paid cash for three

quarts of milk on that date. On the 2d, Peter Jones had one-half dollar's worth of tickets shown by the entry in the upper left hand square. On the same date the entry in the lower right hand square indicates that he bought two quarts of milk and paid cash. On the 3d he had two quarts of milk on tickets. Against Charles Hall the entry in the upper right hand square on the 1st indicates that he has two and one-half quarts of milk charged, on the 2d two quarts, on the 3d three quarts.

When milk is taken from a dairy for delivery a record of the amount should be made. When the milkman returns the amount brought back should be recorded and the difference between the two accounts compared with his sales. In this way any mistakes may be discovered and corrected. This system is not simply a convenience, — it is an absolute necessity when several men are employed. It not only serves as a means of discovering dishonest men, but serves to keep honest men honest. An otherwise good milk business may be ruined by poor bookkeeping and lack of attention to small bills and the details of the business. The system of delivering to fill orders taken the day before is said to be coming into vogue in some places where there is a good trade.

CXXXII — CREAM.

784. *Kinds of cream demanded* — Cream of various degrees of richness is called for both in the wholesale market and by private consumers. For the most part but two grades are recognized, known respectively as thin and thick cream. Thin or common cream may contain from 15 to about 25 per cent. of butter fat. Thick cream, also sometimes called "coffee cream," "breakfast cream," etc., generally contains from 35 to 45 per cent. butter fat. The heavy grades of cream, or thicker creams, are generally sold on a guaranty of the percentage of butter fat. All cream demanded by the trade, whether wholesale or retail, must of course be sweet. Market cream may be produced in either of two ways: viz., by one of the so-called gravity processes, which can produce only thin cream; or by the use of the separator, by which cream of either variety may be produced.

785. *Comparative merits of gravity and separator processes of separating*

cream — The value of any system for extracting cream from milk depends upon the thoroughness with which the butter fat is separated from the skim milk. Gravity systems, *i. e.*, systems where the milk stands and the cream rises to the top under the best conditions, will have from .1 to .5 per cent. of butter fat in the skim milk. A good separator leaves only from .01 to .05 per cent. of butter fat in the skim milk. The significance of such differences as are practically certain to exist in the thoroughness with which the butter fat is extracted by the two systems is made very apparent by the following table: —

Difference in Skim Milk Test. Per Cent.	Number of Cows Kept.	Pounds of Butter Gained Per Year.	Number of Dollars Gained Per Year.	Gain Equals Interest at 5 Per Cent. on Dollars.
.05	10	25	6.25	$125
.1	10	50	12.50	250
.2	10	100	25.00	500
.5	10	250	62.50	1,250
.2	20	100	25.00	250
.2	40	400	100.00	2,000

The figures in the table are computed on this basis: average milk yield of cows 5,000 pounds per year, selling price of butter 25 cents per pound, interest at the rate of 5 per cent. As the differences assumed in the first column are in many cases exceeded it must be concluded that a centrifugal separator is likely to prove a profitable investment, for the cost of operating one is not likely to exceed the cost of furnishing the ice that is essential to the proper management of any gravity system which will produce sweet cream fit for market.

786. *Gravity system* — In all gravity systems the separation of cream depends upon the fact that the specific gravity of the butter globules is less than that of the other constituents of the milk and that, therefore, when the milk is allowed to stand the butter globules, being the lighter, find their way to the top, carrying with them more or less of the other constituents of the milk. There are many gravity systems of creaming milk. The old-fashioned system of setting in small pans is, however, out of the question where cream for the market is to be produced upon a large scale, since the

cream cannot readily be obtained sweet. There have been urged upon the attention of the farming public within the past few years a number of so-called separators, consisting essentially of a can, sometimes of peculiar construction, in which the milk diluted with a certain proportion of water is to be set. The word "separator" applied to such cans is a misnomer and is apparently used to catch the unwary. The term "separator" is properly applied only to machines in which the cream is separated by the centrifugal process. No dilution system is suited to the production of cream for market, neither is it believed that it is worthy of adoption under any circumstances. More perfect separation of cream from the skim milk is secured under the best management by some of the other systems. Moreover, the food value of the skim milk produced in any dilution system is less than that of the skim milk produced by other systems. There is but one among the gravity systems which can be used for the production of cream for market, *i. e.*, the so-called deep-setting or submerged system. In this system the milk is strained while warm into deep cans which are at once submerged in cold water. The Cooley system is the best known in this country and is, without doubt, as good as any. The Cooley creamer is a copper-lined tank with or without an elevator for lowering and raising the cans. There are many styles and sizes. This tank is provided with inlets and outlets whereby a slow current of water can be kept moving slowly

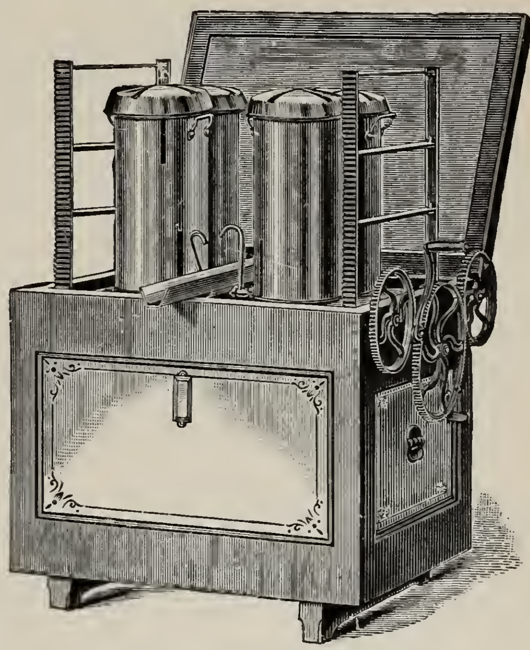


FIG. 248. COOLEY CREAMER.

through it. Unless the source of supply is especially cold, broken ice should be kept in the water, the temperature of which should be maintained as low as possible. The milk is strained into heavy tin cans which hold about 18½ quarts. These cans are fitted with glass panels both at top and bottom so that the amount of cream can be readily seen both before and after drawing the skim milk. These panels are graduated, the interval between two lines being known as a space. The amount of cream in a space is equal to about three-fourths of a pound. The cans used in Cooley creamers are covered and when they are placed in the water they are entirely submerged. Air confined beneath the cover and the rim of the can prevents water from mixing with the milk. Under favorable conditions which, briefly stated, are, water not above 35° F. in temperature, milk which creams easily, *i. e.*, the product of new milch cows fed on succulent food, and especially that of the best butter breeds (Jersey and Guernsey), and milk at a temperature of at least 90° when put into the cans, the Cooley system gives good results. The separation of the cream is practically complete in about 12 hours and the skim milk contains not more than .2 per cent. of fat. Having been rapidly cooled and kept cold, cream separated by the Cooley system is perfectly sweet when taken from the creamer. It is, however, comparatively thin. The percentage of fat in it varies in accordance with numerous conditions, but is commonly not in excess of 20 per cent. There is considerable demand for cream of this grade, and for some purposes it is preferred to separator cream.

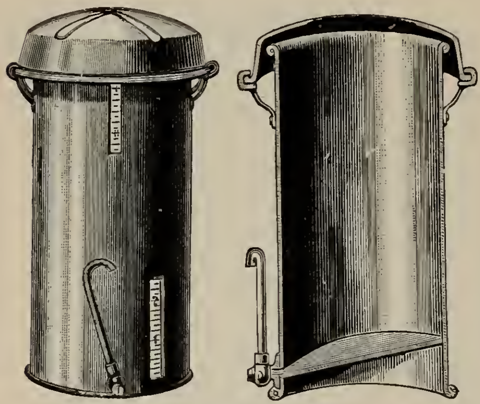


FIG. 249. COOLEY CAN, EXTERIOR AND SECTION.

787. *Centrifugal separators* — The system by which milk is creamed by centrifugal force is of comparatively recent origin. In this, as in gravity

systems, separation depends upon the fact that the butter fat is lighter than the other constituents of the milk. The tendency of any body when rapidly whirled to fly away from the center in a straight line is well known. Further, every boy knows that on being whirled at the same rate in a sling at the end of a cord a stone when released will go much farther than would, for example, a bunch of feathers; in other words, that the heavier a body is the more strongly it is influenced by centrifugal force. It will be understood, then, that when milk containing the lighter butter fat and the heavier milk serum is rapidly whirled at a high rate of speed, in separators usually equaling from 5,000 to 8,000 or more revolutions per minute, there must be a tendency for the heavier portion (the milk serum or the skim milk) to go to the outside and for the lighter portion (the butter fat or cream) to gather at the center. This statement does not take into account all the factors which exercise an influence in the separation of cream in the centrifugal separator, but it will, perhaps, suffice to give a general understanding of the most important principle involved. All separators must be so constructed as to provide an outlet starting near the center of the bowl for the cream, and another starting from the periphery of the bowl for the skim milk. Separators of different makes differ widely in form and details of construction. Nearly all prominent styles are made in sizes suited to every requirement, from small hand machines separating, perhaps, 300 or 400 pounds of milk per hour, up to enormous factory sizes, separating a number of thousand pounds. Most of the leading makes of separators can now be depended upon to do efficient work. In selecting a machine the chief points to be looked for are the following: —

1st. Completeness of separation, *i. e.*, the machine should produce skim milk showing a very low percentage of butter fat.

2d. Durability. This will depend upon quality of materials and workmanship and to some extent, it may be, upon the speed at which the machine must be run to do good work.

Other points which should be considered are: ease of running, facility with which the machine can be cleaned, the range of temperature at which it will do good work, the reliability of the company of which it is bought,

and nearness to the place of manufacture or a general office where repair parts if needed can be readily obtained or repairs made. There is considerable variation in different machines, in respect to the quality of work done when the milk has a temperature below that which is considered best. All separators will do the best work when the temperature of the milk to be separated is about 85° F. Some machines will do fair, although not equally good, work with milk at temperatures as low as 50 or 60° F., while others will fail utterly at such temperatures. As a matter of fact it is not economy to undertake the separation of milk at these low temperatures ; nevertheless, owing to accidental conditions, it may sometimes be necessary, and it is an advantage if the machine is capable of still doing fairly close skimming. As regards speed there can be no doubt that under otherwise similar conditions the machine which will do good work at the lowest speed is to be preferred, since the amount of wear tends to increase, to some extent at least, as the speed increases. Before purchasing a machine it should be given at least a week's trial under the usual farm conditions and a written guaranty should be obtained that the machine purchased will do work of a certain specified grade of efficiency. Such a guaranty is desirable because it appears to be unavoidable that individual machines even of the same make shall vary. This variation is due to slight peculiarities in construction—peculiarities which cannot be detected by ordinary examination, and which only appear after actual use. Almost any power may be used for operating separators. It is believed that in convenience the various powers would range in about the following order : Electric motor, water motor, steam, animal power, and man power. Some of the hand machines when turned but for a few minutes appear to run quite easily ; but the operation even of

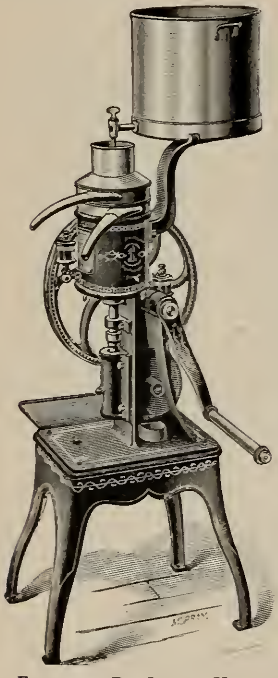


FIG. 250. DE LAVAL HAND SEPARATOR.

a small separator by hand is far from being easy work and, when the quantity of milk to be separated is considerable, some other power should be used if possible. A belt machine will be needed for operation by either of the motors named, by steam engine, or by animal power. Many machines are now run by direct application of steam admitted under moderate pressure to a steam turbine which is a part of the separator. These machines possibly consume somewhat more fuel to do a certain amount of work than others, but they are very convenient, simple in construction and not likely to get out of order, and are much used. The operation of the separator requires care and intelligence. Minute directions for operation and care are furnished by all makers. The most important points are to see that the machine is in perfect adjustment and balance and that it runs evenly and smoothly without undue jar or vibration and without much noise and that the parts are kept properly oiled ; that the speed of the bowl is right and that the temperature of the milk is also right. The separator, as has been remarked, may separate either light or heavy cream. The quality of cream obtained from the centrifugal separator is usually determined by the distance from the center of the bowl from which it is taken. This is determined in most machines by the set of the so-called cream screw. This can be turned a little farther in or out. It requires but a very slight turn to affect the quality of the cream greatly. The nearer the center the cream screw is set the thicker will be the cream and of course the smaller the amount from a given quantity of milk. The quality of the cream yielded by a machine may also be affected by the rate at which the milk enters the machine and the speed

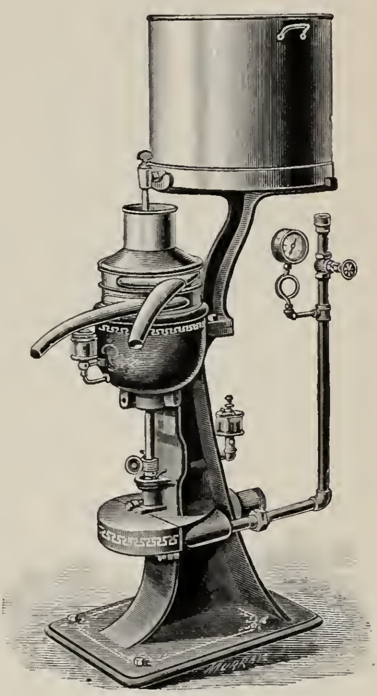


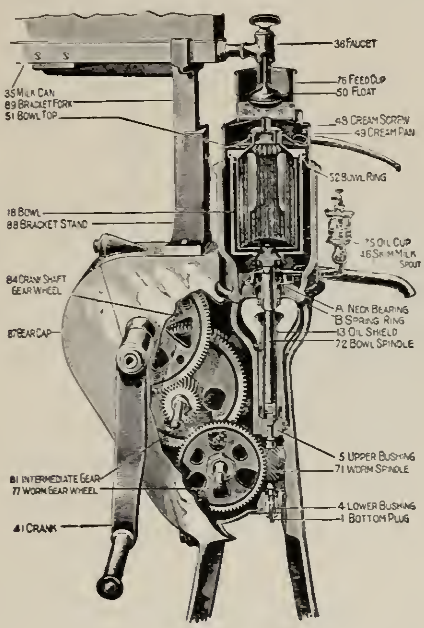
FIG. 251. DE LAVAL TURBINE SEPARATOR.

of the bowl. All machines are, however, furnished with automatic devices which are intended to regulate the rate of inflow. The larger the quantity of milk passing through the machine, the greater the amount of cream and the lower its percentage of fat. The lower the speed, the lower the percentage of fat in the cream. Speed also affects the completeness of separation. The higher the speed, the less fat will be left in the skim milk under otherwise similar conditions. In order that any given separator shall do good work, it should be run at the full speed recommended by the makers and the bowl should run steadily and smoothly without any perceptible jar or trembling. Such jar may be due to the fact that the bowl is not perfectly balanced. If so it should be sent to the manufacturer. The bowl, however, even if perfectly balanced, may sometimes tremble because the bearings of the machine are not perfectly adjusted or because the machine is not set level or upon a solid foundation. The bowl should not only run smoothly and at the right rate of speed, it should also run at a perfectly uniform speed. If there be much variation in the velocity of the bowl, separation is more or less imperfect. Turbine separators are more likely to run at varying speed than are those run by belt power. With ordinary workmen the speed of machines run by hand power is also subject to much variation.

788. *Handling separator cream* — As has been pointed out, the temperature of the milk for separation by the centrifugal machine should be about 85°. The cream as it leaves the machine has about the same temperature and will appear comparatively thin, even if rich in fat. Such cream should be cooled immediately after separation and it should be kept cold until used. By far the most satisfactory way of placing cream in the hands of consumers is by the use of bottles, which may be of similar shape to those used for milk and closed in the same way by the use of paper discs.

789. *Pasteurization of milk and cream for market* — The objects in view in Pasteurization are two: viz., to kill any disease germs which may be present, thus rendering the milk a safe food; and, second, to kill those germs that are practically invariably present which cause souring and fermentations of various kinds, in order that the milk may keep in condition for use a longer time. With proper Pasteurization milk will keep for several

days under ordinary conditions, and by refrigeration it can be kept for such length of time that it may be used on ocean steamers or under all circumstances where it is impossible to frequently obtain a fresh supply. The fact that milk may, under some circumstances, contain bacteria to which diseases are due, has been pointed out (769). Recognizing this fact, some consumers insist on having all milk for use in their families Pasteurized or



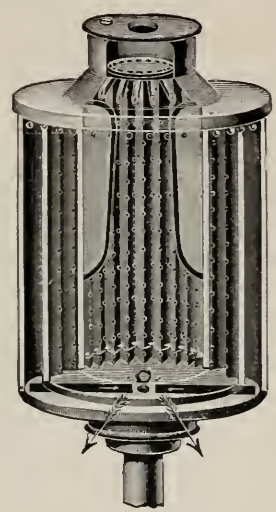


FIG. 252. DE LAVAL SEPARATOR. FIG. 253. UNITED STATES SEPARATOR.
SECTIONAL VIEWS.

sterilized. Most prefer Pasteurization because it affects the flavor of the milk to a much less degree. As a result of his investigations, Russell finds that Pasteurization properly carried out will, on the average, kill 99.7 per cent. of the germs found in milk. Russell finds, moreover, that Pasteurized milk can be used for any purpose for which ordinary milk is used. It is the presence of the tubercle bacillus in milk that is most dreaded, and among disease germs it is the one which, under ordinary circumstances, is most likely to be present. The tubercle bacillus is destroyed by either of the following treatments: A temperature of 149° F., for 30 minutes; a

temperature of 155° F., for 15 minutes; or a temperature of 167° F., for 10 minutes. Milk may be heated to 165° F., if quickly cooled afterwards, without developing a boiled taste, so that it is possible to render it a safe food, so far as tuberculosis at least is concerned, without giving it a cooked flavor. It is necessary, however, that means should be provided whereby the milk can be cooled very rapidly from the Pasteurizing temperature to 50° or below. As a rule, a temperature of 155° to 160° for from 10 to 15 minutes is regarded as sufficient to destroy all germs of tuberculosis. Milk

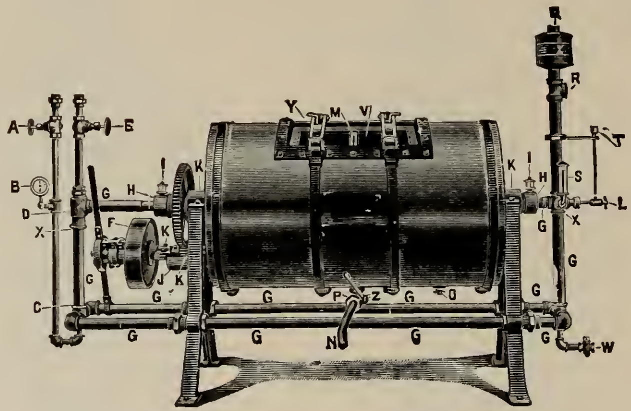


FIG. 254. POTT'S COMBINED CREAM RIPENER AND PASTEURIZER.

for family use can easily be Pasteurized at home by placing the bottles in a kettle containing water to the neck of the bottles, covering the kettle, bringing the water to about 160°, allowing it to stand for about 20 minutes and then cooling as rapidly as may be without breaking the bottles. To prevent the latter from jumping while in the kettle as the water heats, they may be set on a tin plate with holes punched in the bottom. Where milk is to be Pasteurized on a commercial scale special Pasteurizing apparatus will be required. A number of different forms have been devised. The one now generally regarded by competent authorities as most perfectly fulfilling the requirements is Pott's combined Pasteurizer and cream ripener. Wing clearly states the points essential in a good Pasteurizing machine, as follows: —

"Quick, perfect, and uniform heating of the milk ; perfect control of the temperature ; quick and uniform cooling ; compact form ; ease of cleansing ; absence of pumping arrangements ; security against reinfection during the process," *i. e.*, the arrangement for cooling and handling the milk when taken from the machine must be such that bacteria will not gain entrance to it. Directions for Pasteurizing are furnished by the makers of different forms of apparatus and no attempt will be made to give details here. One further point, however, must be noted. The milk which is to be Pasteurized must be as fresh as possible. Russell and Farrington point out in bulletins 44 and 52, Wisconsin Experiment Station, that milk which has developed as much as 1-5 of 1 per cent. of lactic acid is too sour for satisfactory results. This amount of acid cannot be detected by smell or taste, and accordingly some accurate means of testing milk to determine whether the amount of acid is in excess of the figure given is necessary. Farrington's alkaline tablets will be found convenient for this purpose. These may be purchased of dealers in dairy supplies in packages of varying sizes. They will keep indefinitely. When milk is to be tested dissolve one tablet in one ounce or 30 *c. c.** of water. Wing clearly describes the method of making the test as follows : "Then with a cup or other convenient vessel and a small measure of any suitable size the comparative acidity of different milks can be readily and quickly determined as follows : put a measure full of milk into the cup and add two measures of the tablet solution. If the pinkish color disappears, more than 1-5 of 1 per cent. of lactic acid is present and the milk is too sour for Pasteurizing purposes. If the milk remains pink, less than 1-5 of 1 per cent. of lactic acid is present and the milk may be safely used. A convenient measure for this purpose is made by simply soldering a piece of stiff wire to the side of a No. 10 cartridge shell after the manner of the milk measuring dipper." Cream may be Pasteurized in essentially the same manner as that described for milk and it is equally necessary that it should be comparatively free from acid for good results. On the whole the demand for Pasteurized milk is comparatively small. It must of necessity considerably increase the cost however it may be done,

**c. c.* stands for cubic centimeter.

and although there may be real danger of contracting disease through the consumption of natural milk this danger on the whole does not appear to be very considerable and the great majority of individuals will prefer normal milk. They so prefer it not simply because it is cheaper, — they in most cases like its flavor better. Pasteurization does not give an actually cooked flavor to milk — it does, however, change the flavor and in the opinion of many it renders milk more difficult of digestion. It seems to be generally agreed that our efforts should be directed rather to the production of thoroughly sound milk of good keeping quality, milk from healthy cows, handled by healthy persons, rather than that we should be careless either as to the cows, stable management, persons handling it, or methods of handling, and then attempt to make it safe food by Pasteurization.

790. *Modified milk* — Modified milk is milk prepared for special purposes such as food for invalids and infants or in accordance with prescriptions from doctors. It is milk which has been modified or changed in its composition by some special treatment to which it is subjected. The modification may take any one of various directions. Cow's milk differs from mother's milk chiefly in containing more albumin and casein and less sugar. Cow's milk can be made more nearly to resemble mother's milk, by first passing it through a separator which extracts the fat, then adding : distilled water to reduce the proportion of albumin and casein, and milk sugar to raise the proportion of that constituent to the desired point ; and then restoring as much cream of known composition as may be necessary to bring the percentage of fat to an equality with that usually found in mother's milk. Almost any desired modification may be produced by the employment of somewhat similar means, but it will be at once seen that to make such modifications must be out of the question under ordinary farm conditions. A chemical laboratory and chemical reagents are necessary for the purpose of making exact analyses and considerable complicated apparatus, delicate scales, etc., must be at hand. The production of modified milk may possibly constitute a profitable business for some farmer's boy ; but he can hardly expect both to attend to the ordinary routine of the farm and at the same time to do work of this kind. There are a number of com-

panies mainly located in cities engaged in the production of modified milk. The Walker-Gordon Company is one of the most prominent of these. It has offices in various cities. The system followed by this company is briefly as follows : —

The milk is made from healthy cows which have been tuberculin tested. The attendants are healthy young men under medical supervision, being examined by a doctor once in three months. The stables are kept clean both from a practical and from a bacteriological point of view. The milk is handled and strained in the best manner possible. The milkers wear white suits sterilized daily. They are obliged to wash their hands in carbolized water before milking, for the purpose of destroying possible germs. The milk is all run through a separator whether it is to be disposed of as milk or cream. It is cooled by use of the Star cooler, bottled and packed in ice, or, in winter, in ice water. All utensils used in handling the milk are sterilized with dry steam, *i. e.*, steam from a boiler under considerable pressure. The milk is delivered at the laboratory at the temperature of 40° F. or below. The modified milk is put up wholly on prescription. The company has also a retail cream and milk trade. The milk retails at from 12 to 15 cents per quart. The prescription trade is conducted as follows : The doctor in attendance upon the patient sends his prescription to the laboratory in the same manner that he might send a prescription to the druggist. It is filled and delivered in glass tubes,— each tube containing sufficient milk for one meal, whether for the infant or for a patient. The tubes are plugged with antiseptic cotton. The cost of production, and consequent high price at which such milk must be sold, necessarily limits the amount of this product which can be used. It limits the amount in two ways : first, as to the number that will ever use it, and, second, as to the length of time they will use it, especially for infants. The processes of Pasteurization and sterilization are not employed by the makers of modified milk unless specified by the prescription. In the opinion of the writer, while the cost of filling perscriptions and putting up the milk as described must always be high it would be quite within the bounds of possibility for an intelligent farmer by the use of the separator, distilled water, and milk sugar, which

can be readily purchased, to put up in ordinary bottles of say one-half pint or pint sizes a grade of milk (which of course must in the first place be produced under the very best conditions) which, resembling mother's milk more closely than ordinary cow's milk, would be better suited as food for infants and which handled as suggested might be sold at such prices that there would be a considerable demand for it.

791. *Certified milk* — The term certified milk as ordinarily understood designates milk that is guaranteed to contain a certain definite percentage of butter fat. H. B. Gurler of Chicago (and there no doubt are others) sells a certified milk containing exactly 4 per cent. of butter fat, neither more nor less. Knowing the percentage of fat in the milk the customer can modify it to suit himself. There is quite a demand for milk of this character from well-to-do consumers. Many engaged in selling milk of this class produce a milk with more than 4 per cent. of fat. Milk offered for sale as "certified" is also generally certified to be made from healthy cows under sanitary conditions, and in many cases from tuberculin tested cows.

792. *Viscogen* — When cream is Pasteurized, although it may contain a high percentage of butter fat, it appears comparatively thin and viscogen is a solution prepared for restoring its consistency. The solution is made in the following way: Dissolve 2½ parts of cane sugar by weight in 5 parts of water. Add 1 part of quicklime to 3 parts of water. When the lime is thoroughly slaked and has stood some time, strain the lime water and add it to the sugar solution. Mix thoroughly, allow it to settle; and use only the clear liquid. Viscogen must be used with care. The amount required is generally about 1 part to 150, or ½ pint to a 40-quart can. If the use of this amount affects the flavor of the cream to a noticeable degree, the amount should be reduced. The amount of lime thus added to cream by the use of viscogen is less than the amount of variation in the percentage of lime found in the milk of different cows. Professors Babcock and Russell, who discovered and have experimented extensively on the use of viscogen, hold that it is entirely legitimate and absolutely unobjectionable. In some states or cities the laws prohibit the use of any foreign matter in cream sold as such. In such localities cream to which viscogen has been added may,

however, be sold under some distinctive name, such, for example, as "visco-cream." The use of viscogen increases the body of the cream, and it so increases the viscosity that it will whip better.

793. *Milk preservatives* — The fact that the addition of certain substances to milk results in killing bacteria of all kinds, and thus extending the time during which it will keep sweet, has been pointed out (773). It has also been pointed out that the use of none of these substances can be recommended. Nevertheless, the number of special preparations containing them are offered in our markets, and without doubt they are considerably used, especially in cream which must be shipped considerable distances and which is to be sold by grocers, in local milk depots, etc. These preservatives usually contain either salicylic acid, boracic acid, borax, or formaldehyde. These substances are not classed as poisons. Nevertheless, they may have an injurious effect on the health of any person who regularly takes a small quantity into his system. Their use, of course, makes it possible to ship cream or milk to far greater distances and at less expense than by the adoption of the more legitimate methods of keeping it sweet. Such preservatives are sold under various names supposed to be attractive, such as "preservaline," "iceline," "freezine," "milk sweet," etc. According to the dairy laws of some states the addition of any such substances constitutes an adulteration. But whether this is the case or not, no well-meaning and conscientious farmer should use them, as it is well known that they are a menace to health.

CXXXIII—BUTTER MAKING.

794. *General considerations* — As has been pointed out (752), but little butter is now generally made on the farm. The reasons are several. The labor cost of making butter is less when large quantities are handled together. When large quantities of butter are to be daily made it becomes possible to employ for the work specialists who, devoting their entire time to this business, acquire a degree of experience and skill which can hardly be expected of the busy farmer or his wife. The average quality of butter produced in creameries, partly as the result of the last mentioned

consideration, but in part for other reasons which will be pointed out, is better than the average quality of the product of home dairies. That such is the case is evident from the fact that the quotations for creamery butter in our markets are higher than those for dairy butter. Where large quantities of butter are to be made, it becomes possible and necessary to bring all the conditions under better control than is usually possible in the

Fig. 255. Butter Making. The Old Way.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. of Agriculture.

home dairy. There it will pay, moreover, as the quantity is large, to use the very best forms of dairy apparatus ; and the butter maker, devoting himself solely to that work, can readily keep better informed as to the latest improvements and best practices in the art. It is not to be wondered then that butter is now for the most part made in factories, but still another consideration doubtless has considerable weight. The farmer himself is, in the majority of instances, too much occupied with other work to himself attend

to butter making, and the farmer's wife to an almost equal extent is distracted by numerous cares and responsibilities so that freedom from the work essential to the production of good butter is welcomed in the large majority of instances. In some cases, however, the farm is not so located that milk or cream can be sent to the factory. In other cases the farmer has built up a special trade for high class products which he finds exceedingly profitable or perhaps he sees the possibility of building up such a trade. Under such circumstances the butter must be made at home and home butter making will therefore be briefly considered.

FIG. 256. BUTTER MAKING. THE NEW WAY.
By courtesy of H. E. Alvord, Chief Dairy Division, U. S. Dept. of Agriculture.

795. *Good butter can be made only from good milk and cream* — For the production of butter of the very highest quality it is essential that milk and cream should be produced under conditions precisely similar to those already dwelt upon at considerable length which are essential to the production of the best milk and cream for family trade (765-773). Good

butter can be made only from sound milk and cream handled in such a way as to keep it as free as possible from sources of contamination of every possible kind. It is possible to make butter by churning the whole milk, but it is not possible to make from a given quantity of milk as much butter by this system as can be made where the cream is first separated from the milk. The first step, then, in butter making is the separation of the cream. Touching this matter the considerations which should be given weight in deciding upon the system of separation are the same as those already

FIG. 257. ROOM IN DAIRY SCHOOL, MASSACHUSETTS AGRICULTURAL COLLEGE.

stated (785). It must be concluded that under most circumstances the centrifugal process should be employed, as without doubt more butter can be made from a given quantity of milk when the cream is separated by the centrifugal process than can be made when any other method of creaming is followed. Exhaustive churning, *i. e.*, churning which recovers nearly all the fat that is present in the cream, is possible with creams of widely varying degrees of richness. Where the cream is separated by the submerged

system it will ordinarily contain from about 15 to 20 per cent. of butter fat. If the separator is used it is common to so set it as to secure a cream containing from about 30 to 35 per cent.

796. *Care of cream* — Cream which has been separated by the use of the centrifugal machine must be quickly cooled as already described (788). In order to make butter of firm, solid texture,— butter that will "stand up" in warm weather, — it seems to be essential that at some time before the ripening process is completed the cream shall have been subjected to a temperature below 50° for at least 6 or 8 hours. In the deep-setting systems this has already been accomplished when the cream is skimmed ; but in the centrifugal and shallow pan systems of creaming this has not been done and this fact must be remembered. Where the quantity of milk is sufficient the best results are obtained when it is churned daily, but if the quantity obtained in a single day is insufficient, or it is thought best for the purpose of reducing labor to churn less frequently, then it must be remembered that good butter is possible only when the cream is kept under the right conditions. The place must be clean, free from odors, and the temperature below 50°. The low temperature is essential in order to prevent the action of the lactic acid germs until cream enough for churning has been collected. Each time that cream is added to the cream pail the whole should be well stirred in order that the whole mass may be kept as uniform as possible. It is not desirable that cream should be kept more than three days. Churning twice weekly may answer very well, but three times will be better.

797. *Ripening cream* — This term designates the treatment the cream receives from the time it is separated from the milk until it is put into the churn. The quality of the butter depends largely upon the changes that the cream undergoes during the ripening process. The texture of the butter that can be made depends in marked degree upon the variations in temperature to which the cream is subjected. Wing says : "That butter will have the best texture which has seen the fewest possible changes of temperature between the time the milk is drawn from the cow and the time it is churned and in which also all the necessary changes in temperature have been made most gradually. Not only will such butter have the best texture

at low temperatures, but it will stand the effects of high temperature better. In other words it 'stands up' under the heat better than butter that during the process of manufacture has been subjected to sudden and great changes of temperature although the final result may have been to keep it at a low temperature." The effects of ripening are more important and more marked upon the flavor of the butter than upon the texture. It is during the ripening that the characteristic flavors of the butter are largely brought out. It is not necessary to the manufacture of butter itself that the cream be ripened at all. Butter may be made from cream just as soon as it is separated from the milk, but it will be of a distinctly different quality from that made from ripened cream. By ripening in the ordinary sense is meant the production of lactic acid in the cream. Under ordinary conditions it is unnecessary to adopt special means of inducing the formation of lactic acid in cream. The germs of the lactic acid ferment are almost everywhere abundant in dairies ; and all that is necessary in order to induce the changes which result in the formation of lactic acid is to bring the cream to a suitable temperature. The lactic acid fermentation will go on most rapidly at the temperature of about 80° to 90° F., but the best results are not obtained at such high temperatures. A temperature between 60° and 70° F. will ordinarily give the best results. Where butter is manufactured upon a large scale it is customary to use what is called a "starter" and it is found that when this is done the results are more uniform and more certain. In home dairies "starters" are seldom necessary ; but if for any reason it is found that cream does not sour readily, the lactic acid germ may be supplied by adding a little buttermilk or cream from the previous churning, a little sour skim milk, or one of the artificial "starters" such as Hansen's or Douglas's lactic ferments, both of which are offered by dealers in dairy supplies. The cream must be thoroughly stirred several times during the ripening process in order to insure a uniform degree of ripeness of the whole mass. If there be any portions of the cream not as ripe as most of it, there will be loss of a part of the butter because these portions will not churn as quickly as the rest and will accordingly remain in the cream and be drawn off with the buttermilk. On the other hand, if any part of the

cream is overripe the casein which it contains will have formed so solid a curd that it will not pass off with the buttermilk, but will remain mixed with the butter. The small white specks seen in poorly made butter are usually of this character. Butter containing curd becomes rancid comparatively soon. The experienced butter maker can determine by inspection when cream is sufficiently ripened. It has a peculiarly smooth, velvety appearance which cannot easily be described, but which, having once been seen, will easily be remembered. The butter maker who has not experience may with advantage employ Farrington's alkaline tablets. By their use the proportion of acid in the cream is accurately indicated. They cost little and may be obtained with directions for their use of any dealer in creamery supplies. Wing gives the following directions for making the test with Farrington's tablets: —

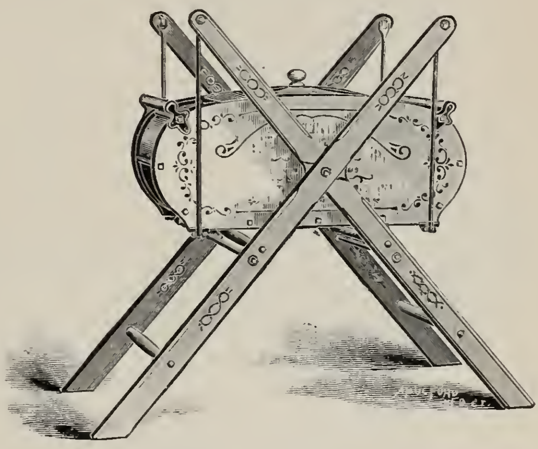


FIG. 258. THE DAVIS SWING CHURN.

"Make a solution of the tablets at the rate of one tablet to 10 *c. c.* of water. Measure the cream and add the solution until the cream retains a pinkish tinge. The tablet solution should always be fresh, not more than 10 hours old. The proper degree of acidity is indicated when 30-35 *c. c.* of Farrington's tablet solution are required to neutralize the acid in 20 *c. c.* of cream."

The acid in the cream is neutralized as soon as the latter begins to retain the pinkish tinge.

798. *Churning* — The number of varieties of churns manufactured and offered for sale in this country is very great. Barrel and box churns without interior fixtures are best. In those churns where the motion of the cream is imparted by means of paddles, the texture or grain of the butter

is likely to be injured. The temperature of the cream should be carefully attended to. It is not perhaps possible to give any exact temperature at which it will always be proper to churn, but from about 55°-65° F. will usually be suitable. It is in general best to churn at such a temperature that the butter will come in granular form in about 45 minutes. The time required varies with the quantity of cream; it may be from 20 minutes to 1½ hours. The churn should be turned at such rate of speed as to obtain the maximum amount of concussion of the particles of cream upon one another. If the churn is turned too rapidly the cream follows the same rotary motion as the churn itself, under which conditions it requires a long time to bring the butter. The cream should dash from end to end of the churn at each rotation. Churning should be continued until the buttermilk has a rather thin bluish appearance; but the butter should be removed from the churn in the granular form. It is not possible to designate the proper time to cease churning in terms of size of granules. It is not always certain that, when the granules reach a certain size, the fat is fully recovered from the buttermilk. It should be remembered, however, that the smaller the granules of butter when removed from the churn, the more perfectly can it be freed from the buttermilk.

Fig. 259. Barrel Churn.

799. *Washing and working* — The first step after stopping the churn is to draw off the buttermilk, then add pure cold water, give the churn a few turns, after which the mixture of buttermilk and water should be drawn off. In most cases two washings are sufficient, but the butter should be washed until the water runs off clear. The granular butter after thorough

draining is removed from the churn to the butter worker. Here it is salted to suit the taste of customers. This in the majority of instances requires the use of about one ounce of salt to a pound of butter. Salt of the best grade only should be used. Some butter makers work in the salt and finish the working in one operation, but somewhat better results can be secured by only partially working the butter when it is salted and setting it away for three or four hours, when it should be reworked until sufficiently dry, and then packed or printed. Salt deepens the color of butter, and unless the salt is worked in evenly the butter will be marbled. A short interval between salting and printing or packing allows the salt to thoroughly permeate the whole mass and the second working does much to insure uniform mixture of the salt as well as removal of any excess of water.

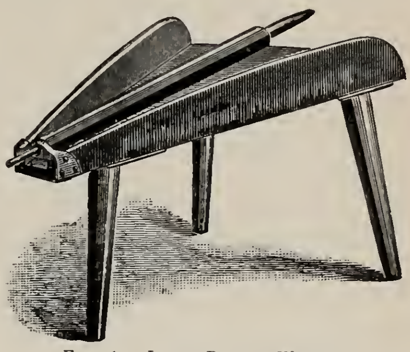


FIG. 260. LEVER BUTTER WORKER.

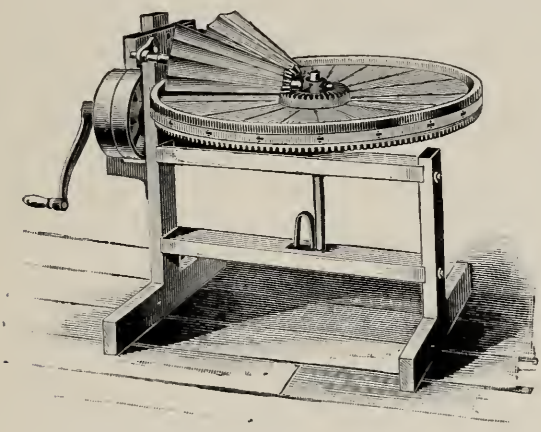


FIG. 261. DAIRY SIZE ROTARY BUTTER WORKER.

800. *Preparing the butter for market* — In the great majority of instances the butter which is made at home finds a near-by market and will be consumed when comparatively fresh. Fresh butter has an aroma and flavor which cannot be retained for any very great length of time however carefully butter may be packed or kept. Butter which is designed for early consumption is commonly printed. Prints are usually made in pound and half pound sizes. Various shapes of prints have been made. The stand-

ard size and shape for a pound print is one that makes a rectangular package $4\frac{5}{8}$ by $2\frac{1}{2}$ by $2\frac{3}{8}$ inches. For fancy trade a print which is relatively longer, broader, and thinner, and which has four distinct and complete ornamental designs, is much in favor. Butter put up in this way has a very attractive appearance and if the farmer can have a special design for his dairy so that his butter wherever seen can be recognized, it will usually be found to help his business. The adoption of such a "trade-mark," as it may be called, shows that the farmer is not ashamed of his product, and, moreover, knowing that his butter will be recognized, the farmer has an added incentive always to make it of the best possible quality. The larger pound prints are almost invariably wrapped in parchment paper, and if to be sent any distance to market the paper-wrapped packages should be packed in specially made carrying boxes of such dimensions that a definite number of packages exactly fills them.

801. *Butter color* — The color demanded by different consumers and markets varies somewhat. The standard, however, is usually the color naturally yielded by the cow when fed upon fresh pasture grass. True, the natural color of the butter from cows of different breeds varies considerably, and it is no doubt partly because the cows kept in different sections vary in this respect that the taste of consumers varies. A number of different materials have been used for coloring butter, but at the present time practically the only coloring matter used is annatto. A number of special preparations of annatto are offered in our markets. All of them are of such strength that but very small quantities need be added to cream to produce butter of the proper shade. Occasionally a person is found who claims that the addition of coloring matter is an adulteration. But if it can be so regarded it is certainly one to which there can be no possible objection. The annatto butter colors are entirely harmless. Against the use of aniline colors there are possibly well-founded objections. Its use, moreover, is really rendered absolutely necessary from the fact that consumers practically expect their butter to be always of the same shade of color, no matter what the breed of cows. This is an impossibility unless coloring matter be used. No cow when fed in winter on dry feeds will produce butter of the same

color as that which she produces when fed on pasture grass. The color of the butter necessarily varies with the food. It follows, further, from what has been said, that it is an impossibility to give exact directions as to the quantity of butter color which should be used. The quantity will necessarily vary from time to time and must be determined by experience. The color should be added to the ripened cream after it is placed in the churn.

CXXXIV — POULTRY FARMING.

802. *Importance of poultry farming* — The importance of poultry farming in the United States is far from being appreciated. According to the United States Census Report for 1890 the number of fowls of the different kinds and of eggs produced (on farms only) is as follows : —

Chickens,	258,871,125
Turkeys,	10,758,060
Geese,	8,440,175
Ducks,	7,544,080
Dozens of eggs,	819,722,916

The value of these fowls on the farm cannot have been less than $150,-000,000, while the eggs at 15 cents per dozen would be worth almost $123,000,000, making a total of about $273,000,000 per year. This it should be remembered is the product from poultry kept on farms alone. If to this should be added the poultry produced in villages and cities the aggregate must be very considerably increased. Even at the figures stated, however, the annual poultry products exceed in value the products of many industries which receive far more attention.

803. *Poultry farming as a business* — Poultry farming, at least in some of its branches, may be hopefully engaged in by more widely different classes of individuals than almost any other farm industry. To make a start in it requires but little capital, nor does most of the work connected with it require the exercise of much strength. As a consequence of these peculiarities of the business it may be carried on even by women and persons in comparatively weak health, provided it is possible to secure occasional help for the little heavy work connected with it. Many entertain

extravagant ideas, no doubt, as to the possible profits of poultry farming and many have conceived the notion that success may be attained with ease. Neither of these views of the matter is correct. Profits depend upon the same elements of character, the same general conditions, as in other lines of business. To succeed requires hard, persistent work, both with head and hands. Success is possible only with the most thorough attention to many little details — details which because they are little are apt to be looked upon as unimportant. The relatively large number of failures among those who engage in some branches of poultry farming is abundant proof that many go into it without sufficiently careful consideration and without the requisite knowledge. If poultry farming is to be engaged in as a business it will, in a majority of instances, be best for the person undertaking it first to learn the business thoroughly by working for some one who is successful in it ; or, if it is not convenient to do this, the beginner should be satisfied to commence in a small way. He will find, however much he may have read and studied up the matter, that there is much which he must learn from experience and, therefore, it is wise not to invest too much at the start. When a small business is made thoroughly successful, then it may be gradually increased ; but, as Robinson has well stated, these two rules should be adhered to : "Keep no more stock than can be given proper care. Keep out of debt." The beginner in any business should consider not only present conditions as to demand, markets, etc., but should form as accurate an estimate as maybe as to the future prospects. Touching this particular phase of the poultry business much that is written is decidedly misleading. Writers are fond of calling attention to the fact that the United States yearly imports millions of eggs, and they go on to state that this is all wrong, and that it is evidence that nowhere nearly as much poultry is kept in the United States as should be. Robinson, writing upon this matter, calls attention to the fact that although the United States yearly imports a million dozens of eggs, this number, enormous as it seems, constitutes less than one-tenth of one per cent. of the total number of eggs consumed in the United States. No one should go into the poultry business with the idea that it never can be overdone. As

in other lines of business, there is often a glut of products of inferior or ordinary quality. On the other hand, the supply of strictly first-class products, whether breeding fowls, table poultry, or eggs, is seldom equal to the demand. Here, as in other lines of business, to quote a phrase which perhaps may be considered somewhat overworked, "There is always room at the top." Poultry farming is a subject of such a character that volumes may well be written upon it. It must here be treated briefly, and we shall consider mainly its relations to ordinary farm conditions. The only kinds of poultry which will be considered are chickens, or barnyard fowls as they are sometimes called, turkeys, geese, and ducks.

CXXXV — BARNYARD FOWLS.

804. *Terms used in describing fowls* — The words common or mongrel as applied to fowls are used to designate the old dunghill stock of no particular breed in some cases, in others more or less improved by irregular infusions of pure blood, or it may be produced by the indiscriminate crossing of fowls of different breeds.

Cross-bred — This term designates the first cross of two distinct breeds.

Grade — This term designates the fowl produced by a system of crossing of one breed upon a foundation stock of another breed or upon common stock.

Pure-bred and thoroughbred — These terms designate the product of the system of breeding from typical specimens of a breed or variety. Pure-bred fowls when mated should produce offspring true to type.

Standard-bred — This term designates fowls bred to conform to the description of that variety in the American Poultry Association's Standard.

Few progressive poultrymen keep anything but pure-bred stock. No mongrel stock, no matter how carefully selected, is likely to pay as well as a good, pure breed. True, some mongrels may pay better than some pure breds but this is by no means the rule.

805. *Classes of barnyard fowls* — The various breeds of fowls, of which there are many, are often included in three classes, viz.: egg breeds,

meat breeds, and general-purpose breeds. Among the best known egg breeds are the Leghorn and Minorca; among meat breeds, Brahmas and Cornish Indian Games; among general-purpose breeds, Plymouth Rocks and Wyandottes. Individuals of the egg breeds are comparatively small and have little value as table fowls. The meat breeds make excellent birds to raise for market. They are of large size, dress well, and some of them are very good layers. The general-purpose varieties are, as a rule, the best breeds for the farmer. They are good layers and make excellent table fowls, having a yellow skin. They are plump and of fairly good size, though smaller than the meat varieties. They have the important advantage that they are in suitable condition to kill any time after they reach the broiler size. For the most part they are quick growers.

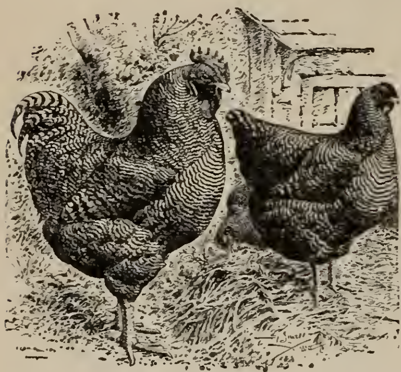


Fig. 262. Pair of Barred Plymouth Rocks.

The classification of breeds which will be here followed is for the most part based upon origin and includes the following: American, Asiatic, Mediterranean, French, English, and Games. Only those having some considerable importance will be described.

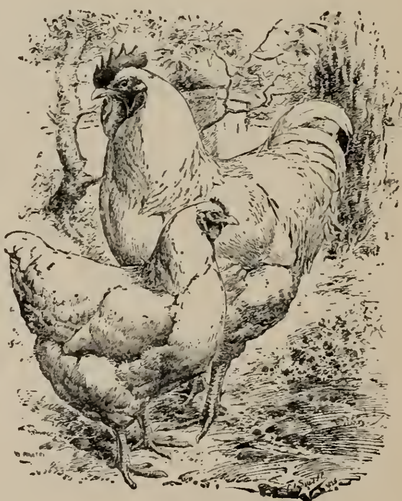


Fig. 263. Pair of White Plymouth Rocks.

806. *Terms used in describing breeds* — The following terms which will be often used in the very brief descriptions of the different breeds here treated should be definitely understood: —

"Very hardy" is applied to breeds that stand exposure well.

"Hardy" designates the breeds that under ordinary conditions are generally free from diseases.

"Fairly hardy" is applied to breeds which require a little extra care in order to keep them free from disease.

"Rather delicate," "delicate," and "very delicate" express the relative vigor of the breeds. The weights where stated are the minimums allowed by the "Standard." They are often exceeded in many breeds.

CXXXVI — AMERICAN BREEDS.

807. *Plymouth Rocks* — There are three distinct Plymouth Rock breeds: Barred, White, and Buff. These are among the most popular breeds in this country. They are hardy, medium to large. Standard weights: cock 9½, cockerel 8, hen 7½, pullet 6½ pounds. Skin, legs, and beaks yellow. They make good broilers and roasters, are good layers and fairly persistent sitters. They rank as general-purpose breeds.

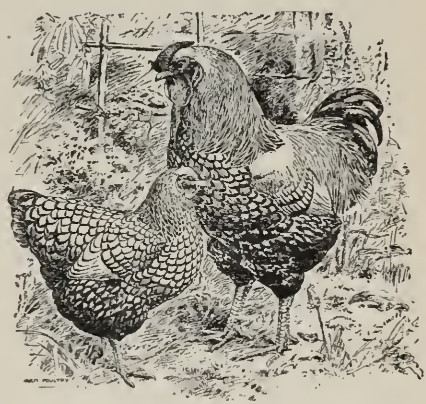


FIG. 264. PAIR OF SILVER WYANDOTTES.

808. *Wyandottes* — Of this type there are seven distinct breeds: Silver, White, Buff, Golden, and Black are the more important. These breeds are hardy. They stand next to Plymouth Rocks in popularity and appear to be rapidly gaining. Standard weights: cock 8½, cockerel 7½, hen 6½, pullet 5½ pounds. Wyandottes are noted for compact, blocky bodies, a small rose comb, yellow skin, legs, and beak, are excellent layers of dark eggs and as table fowls are well suited either for broilers or roasters. They are good sitters, a little less persistent, perhaps, than Plymouth Rocks, and rank among the best of the general-purpose breeds.

809. *Javas* — Of this class there are three breeds: Black and Mottled only are common. Javas are fairly hardy but are not popular in the United

States. They somewhat resemble Plymouth Rocks in general appearance and the Standard weights are the same.

810. *American Dominiques* — Fairly hardy, same size as Plymouth Rock but not popular here at present time.

811. *White Wonders* — Hardy, general-purpose fowls, somewhat resemble White Wyandottes but larger. Shanks feathered. Produce brown eggs. This breed is not popular with fanciers but these fowls are very good general farmers' stock.

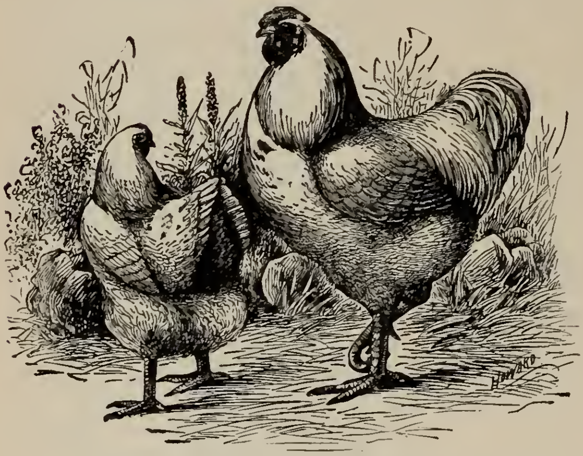


Fig. 265 Pair of White Wyandottes.

812. *Rhode Island Reds* — Hardy, general-purpose fowls of which there are two types: Rose Comb and Single Comb. These breeds are not yet admitted to the Standard and they probably vary somewhat more than the older breeds. Size medium, color reddish buff, said to be good layers of dark brown eggs. They are popular in sections and appear to be gaining in popularity everywhere. An effort has been made to adapt them specially for use as table fowls, but they are not generally regarded as equal for that purpose to the Plymouth Rock and Wyandotte.

CXXXVII — ASIATIC CLASS.

813. *Light Brahmas* — Very hardy, the largest variety of fowls. Standard weights: cock 12, cockerel 10, hen 9½, pullet 8 pounds. White with black markings. Pea combs. Shanks and toes heavily feathered. Good layers especially in winter. Eggs large brown. Very persistent sitters. The Light Brahma is a meat breed. Quiet in disposition and bear confinement well.

814. *Dark Brahmas* — A hardy meat breed about one pound lighter in weight than Light Brahmas. Fair layers of brown eggs. Persistent sitters.

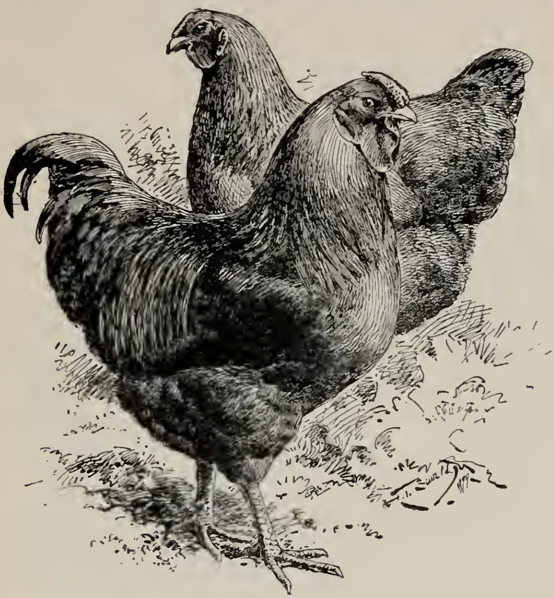


FIG. 266. PAIR RHODE ISLAND REDS.
Courtesy of Samuel Cushman, West Mansfield, Mass.

815. *Cochins* — Of this type there are four breeds: Partridge, Buff, Black, and White. Very hardy, of all breeds least influenced by climatic or other changes, bear confinement remarkably well. Plumage very heavy, shanks and toes feathered. Standard weights: cock 11, cockerel 9, hen 8½, pullet 7 pounds. When bred for eggs said to be excellent layers. Color of eggs brown. Persistent sitters.

816. *Langshans* — Of this type there are two breeds admitted to the Standard: Black and White. Fairly hardy. Standard weights: cock 10, cockerel 8, hen 7, pullet 6 pounds. Plumage heavy, shanks and toes feathered but not as heavily as among Cochins and Brahmas. Legs rather long, beak dark, skin white. Not very popular either for eggs or meat. Eggs brown. Good sitters.

CXXXVIII—MEDITERRANEAN CLASS.

817. *Leghorns* — Of this type there are four breeds of some importance having single combs: Brown, White, Black, and Buff. There are also rose-comb Brown and White Leghorns. They are hardy, rather small in size; combs and wattles, especially of the single-comb Leghorns, large. Ear lobes white. Leghorns are among the best of layers and rank among the most popular breeds. They make fine broilers. They do not bear confinement well. They are non-sitters.

818. *Minorcas* — There are two breeds of this class: Black and White. Fairly hardy. Standard weights: cock 8, cockerel 6½, hen 6½, pullet 5½ pounds. Combs very large, single. Under right conditions, extra good layers. Eggs white, large. Minorcas are fair table fowls but they do not command the best prices. They are said to be very popular in New York and on the Pacific coast.

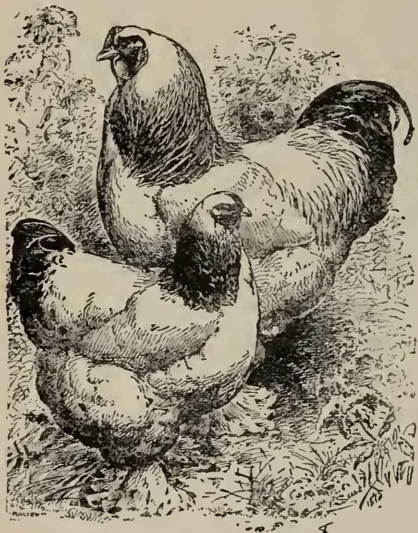


Fig. 267. Pair of Light Brahmas.

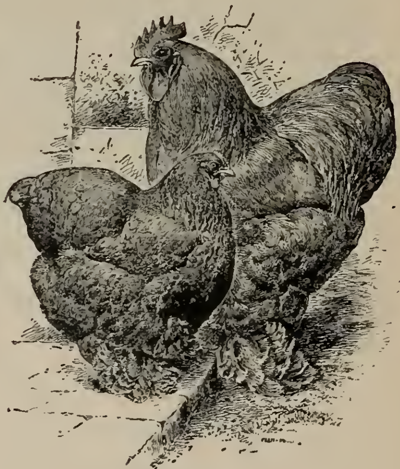


Fig. 268. Pair of Buff Cochins.

819. *Other Mediterranean breeds* — There are several other Mediterranean breeds, among which the Blue Andalusian, the White Faced Black Spanish, the Polish, and Hamburgs, both of several types, and Red Caps are the breeds known in this country. None of them have much popularity. They are small in size, good layers, but are not very hardy.

CXXXIX—FRENCH FOWLS.

820. *Houdans* — The Houdans have a topknot of feathers on the head, are bearded and have V shaped combs. They are of medium weight and have five toes on each foot in place of the usual number, four. The

skin is white. They are good layers and non-sitters, but have never become very popular in this country. Houdans have the reputation of being rather delicate.

FIG. 269. PAIR OF BLACK LANGSHANS.
Courtesy of D. E. Salmon, Chief Bureau of Animal Industry, Dept. of Agriculture.

821. *Other French breeds* — There are a number of other French breeds, among which LaFleche and Crevecœur are recognized by our Standard. They are not, however, often seen.

CXL—ENGLISH FOWLS.

822. *Dorkings* — Of this type there are three distinct breeds : White, Silver Gray, and Colored. They have five toes on each foot. They are said to be rather delicate, except when provided with a large, well-drained range. The size is medium. Only moderately good layers. Good sitters. Very rarely seen in the United States.

823. *Orpingtons* — This is a comparatively new breed. Said to be

hardy and a general-purpose fowl. There are three established varieties, Black, White, and Buff, and of each there are single-comb and rose-comb sub-varieties. They are said to be good layers and good table fowls but they cannot compete in America with the Plymouth Rocks and Wyandottes.

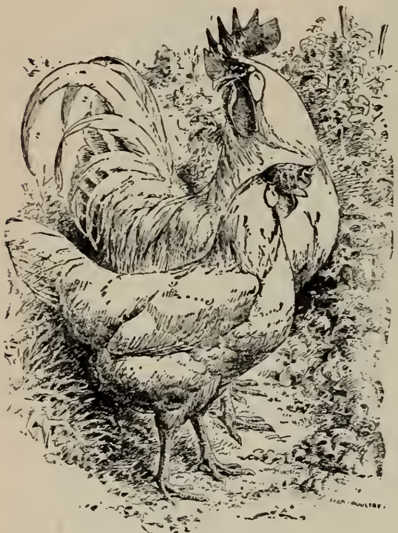


Fig. 270. Pair of White Leghorns, Single Comb.

Fig. 271. Pair of Black Minorcas.

CXLI — GAMES.

824. *Cornish and White Indian Games* — Meat breeds. Standard weights: cock 9, cockerel 7½, hen 6½, pullet 5½ pounds. Valuable only for meat, the breast meat being relatively very abundant and delicious. Skin and leg yellow. Poor layers, good sitters, not very hardy.

825. *Exhibition and Pit Games* — There are eight varieties of Exhibition Games differing only in color. All are characterized by a long leg and neck and a cranelike carriage. These breeds are hardy and average layers. They produce a large proportion of breast meat, but the meat is rather hard. In sections where cock fighting still prevails Games are often kept for domestic purposes, but cannot be considered as good economic breeds. Pit Games are rather shorter in the legs than most of the Exhibition Games.

826. *Foreign and new breeds* — Almost every foreign country has its peculiar breeds of poultry and these are every now and then imported. They are highly praised and advertised for a while by those who bring them to this country. The average poultryman or farmer should not select breeds of this character. They rarely become popular and in most instances the result of investment in them is a loss of money.

827. *The breed for the average farmer* — For the average farmer or poultryman it is best to attempt to keep but one variety. Choose that variety which there is good reason to believe will do best under the conditions that can be given. For most farmers one of the breeds of Wyandottes or Plymouth Rocks is likely to prove as satisfactory as any. It is quite as important to get strong healthy stock as to fix upon the breed. There are strains of stock in all breeds, much inferior in constitutional vigor and hardiness to the general type. Fowls from such strains, although they may have good pedigrees and a long and distinguished ancestry, are likely to prove unsatisfactory.

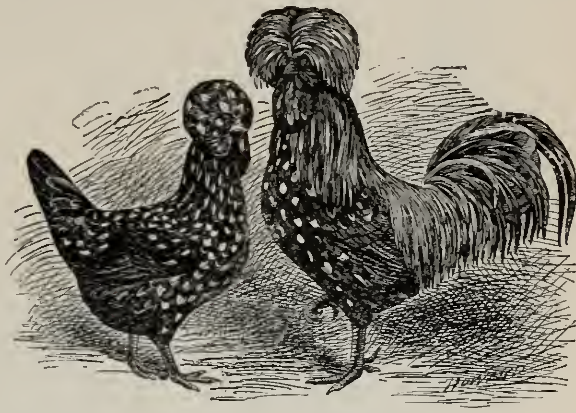


FIG. 272. PAIR OF HOUDANS.
By courtesy of D. E. Salmon, Chief Bureau of Animal Industry, Dept. of Agriculture.

CXLII — GENERAL CARE OF FOWLS.

828. *Location and soil* — The best location for a poultry house is on a southern or southeastern slope with good drainage. A sandy or gravelly soil is usually the best as it holds very little water, is easily cultivated, and thus can be kept fresh and free from disease. Poultry should never be kept in a damp, dark place, but in a dry, light location. In any branch of poultry farming, as in all other kinds of business, nearness to market and the

quality of the market should be considered when deciding upon the location. Poultry products, however, have so high a value per pound that they can endure more distant transportation than many other farm products.

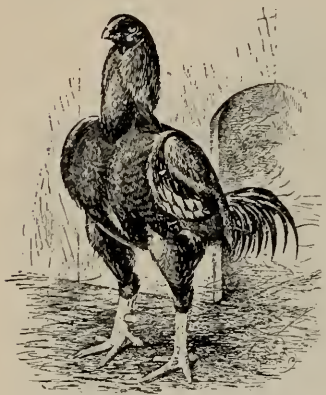


FIG. 273. CORNISH INDIAN GAME COCK.
By courtesy of R. I. Ex. Station.

829. *Buildings for poultry* — If the house can be so placed as to be sheltered from northwest winds, so much the better. Sunshine is a very desirable factor in the poultry house. It should have windows, however, only on the south, if it is possible to build in that manner. On the farm poultry are frequently kept in a part of the barn partitioned off from the rest. If a room can be made on the south side, in such a way that it will be warm, light, and well ventilated, it will do very well. If there is a warm, covered shed, opening to the south, in the barnyard, where the hens can run in winter, it will be a great advantage to so plan the house as to give them ready access to it. The cost of a henhouse is not necessarily great, but without doubt they are many times far too cheaply and flimsily constructed. One should not go into poultry keeping on any extended scale until one has decided to follow the business and, having decided to follow it, it pays to build in such a manner as to secure reasonable permanency. There are two leading types of henhouses now in general use and both with good results. One provides for each flock of fowls a scratching shed, which can be thrown open to the south, as well as a closed compartment for roosts and nests. In the other type no scratching shed

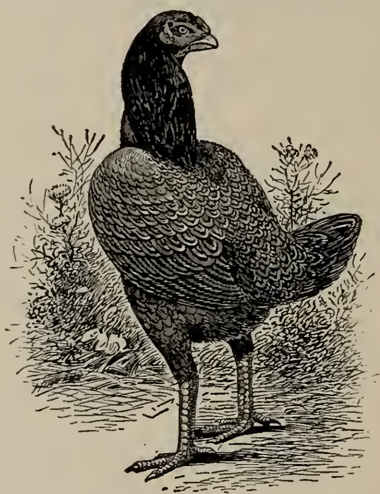


FIG. 273 *a*. CORNISH INDIAN GAME HEN.
By courtesy of D. E. Salmon, Chief Bureau of Animal Industry, U. S. Dept. of Agriculture.

is provided, each flock of fowls having but a single room. If the latter plan of construction is adopted the windows should be so put in that they can be opened in the warm part of the day. In order that they may do their best, accommodations for fowls should be so planned that not more than twenty-five hens at the outside shall be kept in one flock. Twelve or fifteen where kept for egg production will do better, and fifteen fowls will require a house about 10 by 12 feet in size.

Fig. 274. House for Single Flock.
By courtesy of Massachusetts Agricultural College.

830. *Henhouse with scratching shed* — The accompanying cut shows an excellent house for laying stock. The windows face the south and they are of the ordinary size, 6 by 3 feet. Farmers often make the mistake of putting in too much glass. With too many or too large windows, the house is too hot during the hours of sunshine and too cold at night, and fowls suffer frequent colds. The front of the scratching shed is provided with doors in each of which a single sash is set. These doors can be opened and fastened back on days not too stormy or cold and closed in bad

weather or at night. When opened the front of the scratching shed is practically without obstruction, though in most cases poultry netting is put up to keep the fowls in. The scratching shed is 8 by 12 feet, the roosting room 10 by 12 feet. It is possible that a house will be more satisfactory should the scratching shed be 10 feet and the roosting room 8 feet in width. The roosting room is provided with a ventilator. The main door is in the east end. In the partition between the roosting room and scratching shed, which is tight, there is a large door for the convenience of the attendant and a small door for the fowls. The dropping boards are 3 feet wide and 2 feet above the ground. There are two roosts 9 inches above the boards. Nests, which the hens enter from the back but which may be opened on the front, are placed under the dropping boards. There is a pen for sitters 3 by 2 feet in size fastened to the end wall. Water dishes and grit boxes are placed at the sides. The floor of the scratching shed is kept deeply covered with fresh straw. This house is used for twenty fowls and gives good satisfaction. The yards connected with this house have the same width as the pen and shed taken together, 18 feet, and for twenty fowls such yards need to be at least 100 feet long if to be kept permanently in grass, which is desirable.

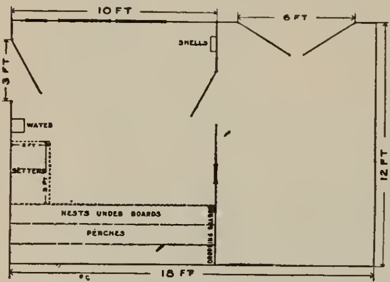


FIG. 275. PLAN OF HOUSE FOR SINGLE FLOCK.
Courtesy of Mass. Agricultural College.

For the construction of yards fence posts standing 6 feet above ground and 10 feet apart should be set. Two inch mesh wire netting is used, but boards should always be placed at the bottom to a height of about 18 inches in order to prevent cocks from fighting one with the other, provided yards adjoin each other. The wire should reach 4 feet higher than the boards. Such a fence will confine fowls of all breeds except Leghorns and Minorcas. The cut, Fig. 276, shows a range of detached houses similar to that described, now in use in the Massachusetts Agricultural College. It was thought best to adopt this style of construction since the houses are

designed to accommodate flocks of fowls which are to be compared one with the other in feeding or other experiments. Where houses are made for ordinary uses it costs far less to accommodate a given number of fowls if the usual style of construction, shown in Fig. 275, is adopted. If it be decided to adopt the scratching shed as a feature of the house, then throughout the range, except of course at the ends, scratching sheds and closed rooms for roosts and nests should alternate in pairs. The plan of construction which allows a passage in the rear of the pens for the several flocks, for

FIG. 276. GENERAL VIEW OF HOUSES AND YARDS.
Courtesy of Massachusetts Agricultural College.

convenience in reaching all parts of the house, has much to recommend it. This style of construction will be sufficiently understood from Fig. 277. Whatever the style of construction adopted, the house should be so made as to be warm and tight. The outside of the building should be covered with good roofing paper and with shingles or other weather-proof covering. Fowls lodged in an ill-constructed house with cracks allowing admission of cold draughts are almost sure to catch colds and contract diseases which destroy all chances for profit.

CXLIII — THE RAISING OF CHICKENS.

831. *General considerations* — Where any large number of chickens are to be raised it is generally advisable to use an incubator. It is believed that it will pay to use an incubator in most cases if more than 100 or 200

chickens are to be raised. It is often difficult to get hens to sit at the desired time. The incubator is always ready for business. Further advantages connected with the use of the incubator are that there are no lice to bother the chickens and that it is easier to care for the eggs, as many more are put together. Eggs which are to be used for hatching, whether in incubators or under hens, should be collected daily and, in winter, several times a day if it is very cold, in order to prevent chilling. If breeding in more than one way, or if attempting to improve the stock by the selection

FIG. 277. HOUSE WITH RANGE OF COOPS. PASSAGE ON BACK SIDE FULL LENGTH OF HOUSE.

of eggs from the best-laying hens, then eggs should be marked when collected, in order that they may be identified. Reject all small eggs, all which are exceptionally large, and all which are imperfect in shape. Eggs for hatching should be kept in a cool, dry place at a temperature of from 40 to 50° F., if possible. Contrary to the usual idea it is not necessary to turn them.

832. *The natural method of hatching and raising chickens* — To manage a number of sitting hens is likely to be a great deal of trouble. True, with fowls of the sitting breeds, many of the difficulties ordinarily met with

can be avoided. In the first place, it is important to carefully select the hens. Not all hens, even of the breeds supposed to sit, are good sitters. The hen should be of a quiet disposition, in fair condition. The body should feel hot underneath, and no hen should be taken that does not allow herself to be handled freely, at least after dark. Sitting hens should be provided with a room by themselves, away from laying stock. The nests should be of good size and only just high enough in front to retain the nesting material. Care should be taken that the nests are sufficiently large and in the rooms where the hens are sitting suitable provision should be made for a dust bath. If sitting in a room with a board floor, use nests with bottoms ; on an earthen floor bottomless nests are better. If a nest with bottom is used it is desirable to place some earth in the bottom and on the top of that a little fine straw or hay. It will be found most convenient to set a number of hens at one time, and the eggs should be tested after about five days and if many are found infertile some of the hens may be reset on fresh eggs. In setting hens it is best to move them from their accustomed nest to the new one at night and no lantern should be used if it is possible to get along without it. The hen should be kept fastened in the nest for a day or two at least, and if many sitters are kept in the same room it will be safest to keep the nests closed all the time, removing the hens from the nests daily for the necessary length of time. Sitting hens should be fed on whole corn and allowed plenty of grit and fresh water. When taken from the nest they should not be allowed to remain off more than about twenty minutes unless the weather is very warm. Chilling the eggs is less injurious during the second week of incubation than at any other period. When the chicks begin to hatch the hens should be watched to see that they are doing well ; and if the hen is inclined to kill chickens or is restless, it will be necessary to remove her and give her eggs to another. If it is seen that some of the chickens are making no progress in getting out and that the membrane is becoming dried, it should be moistened with warm water, especially if it inclines to adhere to the body of the chick. It is almost always possible to place chicks hatched under hens in charge of a smaller number than are required to hatch them. The number must be varied

according to the weather. Twelve is a suitable number for winter, but in summer one hen can care for about eighteen or twenty chickens after they are a day old. Those hens that make the best hatches should be given charge of the chickens. Never allow a sick hen or one with scaly legs to care for chickens. All deformed chickens and those which are very weak had better be killed at once. If the chickens are to be marked this should be done when they are taken from the nest. The best method is to punch the web between the toes with a special punch made for the purpose. Chickens with hens should be kept inside for a few days. Then, unless the weather is especially cold or stormy, they may be placed in a coop out of doors. Many kinds of coops for small chickens with hens are in use. Both the A and the box shapes are common. The coop need have no floor, unless skunks or weasels are likely to trouble. It is much easier to move a coop to fresh ground than to clean the floor. Connected with the closed part of the coop there should be a room inclosed, by means of laths or wire, in such a manner as to confine the hen and allow the chickens to pass freely in and out ; or in case hawks or cats are numerous these runs must be made chicken-tight and the chickens kept in. Unless the coops can be so placed as to be partially shaded by trees, boards should be so put up as to afford protection from the sun. It is best ordinarily to keep the hen confined. The coop should be placed on grass and should be frequently moved to fresh ground. An orchard is an excellent place, as the chickens may be depended upon to eat many of the insects which might otherwise prove injurious, and moreover the shade will be grateful during the warmer months of the year. Sometimes hens begin to lay before the chickens are large enough to wean. If they are kept in the coop they will ordinarily still continue to care for the chickens.

833. *The artificial method of hatching and rearing* — Where the number of chickens to be raised is large, the use of the incubator and brooder is likely to prove much more satisfactory than the attempt to manage with hens, but the best incubator possible should be bought. In deciding which to buy it should be remembered that the claims of manufacturers and agents are sometimes extravagant. It will be safest to select an

incubator such as the one which is found to be in use by large poultrymen. Such men are pretty sure to have learned by experience which is best. The incubator, whatever the kind, should be set up and run as directed by the manufacturer. Be sure to read instructions carefully and correctly. An incubator will not run well without careful attention. Good judgment is required. It is especially necessary that the lamps should be carefully trimmed and filled and that the eggs be turned as directed. The eggs should be tested sometime from about the 5th to the 7th day. It is best to

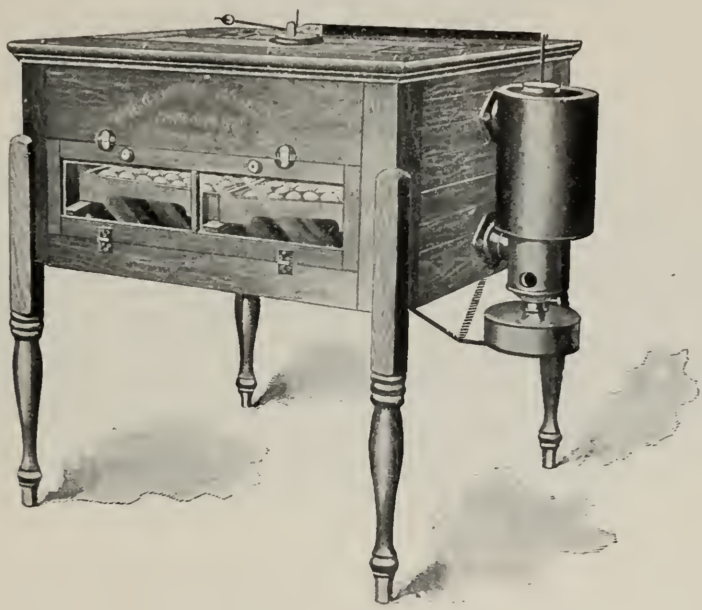


FIG. 278. INCUBATOR, 220-EGG SIZE.

use for this purpose one of the special testers manufactured for the purpose, although very good results may be obtained by the use of a box inside of which a lamp giving a good clear light is placed, on one side of which directly opposite the flame of the lamp a hole has been made of about the size and shape of an egg. In testing, the egg is to be held close to this opening so that all light which finds its way out must pass through the egg. Eggs which are fertile will be found to have a dark spot in them near one

end, and if the shell is not thick and if incubation is well started blood vessels radiating from this spot can be distinguished. Eggs which are not fertile will appear perfectly clear. If removed as early as the fifth day they may be used for many purposes. A beginner in managing incubators should refer constantly to directions and carry out every detail in the management suggested. It will be found a great advantage if practicable to

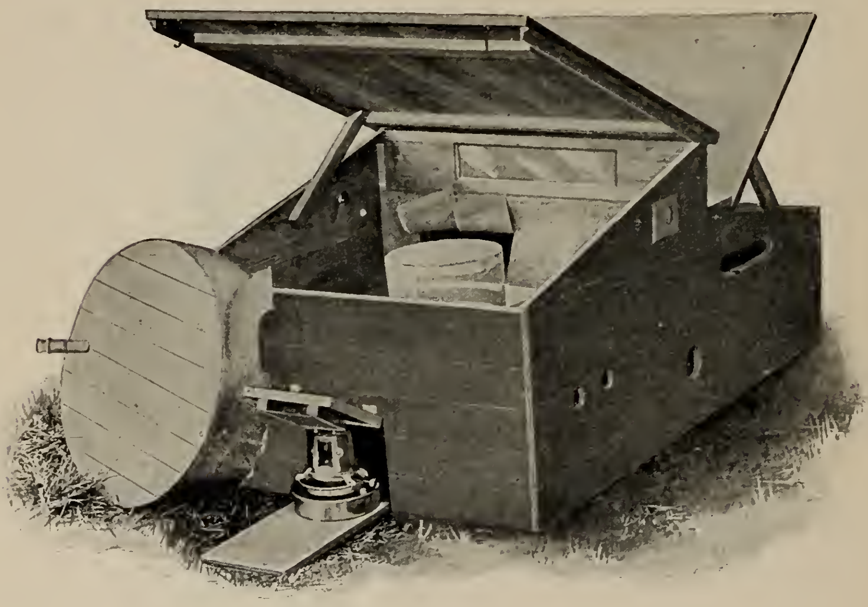


FIG. 279. OUTDOOR BROODER.

secure some one accustomed to the use of incubators to help in setting one up and getting it started. When chicks are hatching the incubator should not be opened unless absolutely necessary. It is best not to be in too great a hurry to remove the chickens. They are often given their first feeding in the incubator.

834. *The brooder* — Chickens which are hatched artificially are best cared for by use of brooders or brooder houses. Sometimes the plan of giving such chickens to broody hens is tried ; and if the hens are of quiet

disposition and have been broody at least a week, and the chickens are quietly put beneath them in the dark, the plan may be successful. This plan is, however, always attended with risk of loss from hens that refuse to acknowledge such chicks as legitimate, and on the whole the use of brooders or brooder houses will be found most satisfactory. There are many good brooders in the market. The cut shows one for outdoor use which has been found very satisfactory. This brooder has three apartments. The total floor space is 36 by 60 inches. The front of the brooder, which is in the rear in the picture, is for use in the daytime. This is lighted by four panes of glass and reached by a runway from that part of the brooder containing the hover. The hover with its thermometer is shown leaning against

Fig. 280. Brooder House.
By courtesy of Rhode Island Experiment Station.

the brooder. The lamp on its slide has been drawn out as it would be when it requires trimming or filling. This lamp has a jacket containing water between the flame and the oil bowl. This keeps the wick from charring and the flame from flickering, thus adding to the safety of the brooder and insuring a more uniform heat. A wire guard covering the perforated iron plate (dome) through which the heat rises from the lamp serves to prevent the chicks from crowding or coming into contact with the heated dome and thus injuring themselves. The temperature beneath the hover is correctly indicated by the thermometer and it should be held at such point, usually about 90° to 92° F. at first, as may be desired, by varying the height of the flame of the lamp or changing the ventilation. The temperature in the

part of the brooder containing the hover is about 10° lower than the temperature under the hover. The temperature in the front or day apartment is of course, still lower, not being materially affected by the lamp. In stormy weather chicks can be fed inside this part of the brooder, but in clear days unless exceptionally cold they should be fed out of doors after they are a few days old. This brooder is fireproof, that part of it containing the lamp being lined with sheet iron, and it is so constructed that no fumes from the lamp can enter the apartments where the chickens are kept. It is possible to keep this brooder out of doors in all sorts of weather not violently cold, and with reasonable attention to management in accordance with directions it will take good care of the chickens. The brooder lamps should be watched carefully. It will harm the chickens to get chilled; but not as much as to get excessively overheated. Great care should be taken not to turn the flame of the brooder lamp too high. In warm weather, especially during the hours of sunshine, chickens in outdoor brooders will not need heat very long. As a rule in ordinary spring and early summer weather the chickens are ready to leave the brooder at the age of from four to six weeks. The brooder should always be started a day or two before the chickens are to be put in, in order to get everything warm and dry. Fifty chickens is a sufficient number for any brooder. When chickens are to be raised on a very extensive scale or out of season a brooder house will be needed. The accompanying cut shows a house which has been giving good satisfaction. It is substantially constructed. A building of equal size could be built much more cheaply and still give good results. It might be covered with paper instead of shingles and a lower pitch to the roof would answer. In this particular case the roof was made high in order to provide liberal room for storage. This building is 16 by 50 feet and 6 feet high at the eaves. It has nine windows facing the south. A walk 4 feet wide runs the full length on the north side. This walk is 2 feet lower than the pens, each of which is 5 feet wide and 12 feet long. There is an indoor brooder in each pen next to the walk so that the lamps can be cared for from the walk. At the west end is a cellar, 10 by 16 feet, which contains a heater and feed room. This building is heated by hot water pipes which run the entire

length under the indoor brooders, but separated from them by the board floor. The space beneath the floor in which the pipes run is open next the walk, which allows the heated air to escape. This building can easily be kept at 70° F. during the coldest weather at comparatively slight expense. From about 50 to 75 chicks are kept in a pen. After the chicks are a few weeks old the heat of the house is sufficient and the brooders are removed or left without special heat. The sides and roof are boarded, papered, and shingled. The ventilator in the center of the building is usually kept open. The floors are of cement, foundations of stone. The outdoor yards are 5 by 30 feet in size.

835. *Coops for large chickens* — When chickens, whether raised with hens or in brooders or brooder houses, no longer need artificial heat, coops of such size and construction as to allow them to roost will be found very convenient. Chickens intended to furnish laying stock do much better if divided into small flocks, each provided with such a coop, and reared in what is called the scattered colony plan. This is always advisable if the amount of land available permits, for the chickens will do much better if they have free range. Coops about 6 feet long and 3 feet wide, 3½ feet high in front, and 2½ feet in the back are a convenient size. They can be made of matched sheathing and painted, or of rough boards and the roof covered with paper. The front should be covered by laths or wire netting to confine the chickens at night while allowing plenty of fresh air. Two roosts can be put in such coops and it will hold about twenty-five chickens for some time. Chickens will do better if the coops are moved every few days to fresh ground. It is not necessary that such coops have floors unless these are required to keep out predaceous animals.

836. *Feeding chickens* — Chickens are successfully fed in a great variety of ways. Methods recommended by two well recognized authorities will be briefly described.

Rudd's method — Rudd advises feeding chickens for the first two weeks on crumbled Johnnycake or waste bread and granulated oats dry, keeping green food and powdered charcoal always before them. After two weeks he recommends the addition of whole or broken wheat or cracked corn.

After three weeks he begins to give moist food such as stale bread soaked in sweet milk thickened with corn meal, the latter making up about one-half of the whole. After four weeks he discontinues the granulated oats. He recommends keeping plenty of cracked corn always before the chickens until they can eat whole corn, after which this should be kept before them.

Boyer's method — For the first week give rolled oats or cut oat meal fed in troughs, alternating with stale bread crumbled, with boiled milk to drink. After the first week feed on mash composed of two parts bran and one part corn meal, or one part ground wheat may be added. To a panful of mash, which should be mixed very stiff so that it shall be dry and crumbly, he recommends adding a handful of meat scraps. After two weeks he recommends the addition of cracked wheat and cracked corn. Grit, oyster shells, and powdered charcoal should always be kept before the chickens. He recommends feeding freely green tops or, if these cannot be had, baked potatoes cut in halves.

Method followed by broiler raisers in Plymouth County — Broiler raisers in Plymouth County follow a very simple method which seems to be rather peculiar to that locality. They feed at first exclusively on fine cracked corn. When the chickens are three weeks old they begin to feed fine scraps, beginning very gradually and slowly increasing. The scraps are fed dry and unmixed with any other feed. These feeders value green food and of course allow grit, charcoal, etc., if necessary. Their method appears to be exceedingly successful in their hands.

The writer has had excellent success raising chickens upon a mash of about one part wheat bran to two or three parts of corn meal mixed with sweet skim milk. To this ration should be added after about three or four weeks a small amount of animal meal or scraps mixed with the mash. While the chickens are small the mash is used four times daily; later, twice. The last feed at night is always fine cracked corn.

Another method which has given good results consists in making a bread composed of a mixture in equal parts of ground corn, wheat, and oats mixed with milk. This bread is baked and fed at first five times daily. After

about four weeks cracked corn, wheat, etc., are fed, whole grain being fed as soon as it is easily eaten.

Success with any method of feeding chicks depends upon care. They should be fed at first frequently. Care should be taken that they are not overfed. It is not safe to give them food of any kind in excess of what they will immediately eat up, unless it be dry grain, and in the writer's opinion it will probably be better not to give any considerable excess above what will be immediately picked up even of this.

837. *Special care for pullets* — Where pullets for laying are raised it is well to remember, first, that the birds will do better if separated from the cockerels comparatively early. Unless the cockerels are of special value as breeding stock it is commonly best to dispose of them as soon as they are large enough for market. The pullets are thus given a much better chance on the range and will come forward more rapidly as a consequence. Pullets which have been reared on the separate colony plan in coops such as have been described, should be moved to the henhouses before the weather becomes cold and stormy. In coops with open fronts they are likely to contract colds if kept out too late. As the nights grow cold the birds will do better if housed in a larger house. Further, moving either pullets or hens always gives a temporary check to the laying instinct. Pullets will lay earlier if moved to their houses comparatively early so that they may become thoroughly accustomed to their new quarters by the time they reach the age when eggs may be reasonably expected.

838. *General care of laying stock* — Laying stock should be so managed as to keep them free from vermin, in good condition, thoroughly vigorous and active. In order to keep them active no better means has been devised than giving them all dry grain scattered over a thick layer of straw. This should be placed in the scratching shed if that is provided, or in the regular pen if there is no scratching shed. This straw should be changed as often as may be necessary to keep it fresh and clean.

A few other points in general management must be carefully looked after : —

(*a*) *Dust boxes and vermin* — Every flock of hens should have access

to a dust box which should be of sufficient size to accommodate a considerable number of birds at one time. It should be kept where the sun will shine on it. If given access to a good dust bath there should be comparatively few vermin. Still, where hens are kept in close confinement the dust bath is not sufficient. Hens should be occasionally dusted with good insect powder. To do this hold the hen by the legs in a shallow box. Shake the powder among the feathers and by rubbing make it reach all parts of the body possible, especially under the legs, wings, etc. This should be done thoroughly. The box will catch whatever powder falls, and this of course

FIG. 281. GALVANIZED IRON DRINKING FOUNTAINS.

may be used for other birds. The fowls should be carefully watched, and whenever lice appear insect powder should be used as described. As a further means of keeping down vermin, the roosts and nest boxes should be occasionally washed with kerosene. Hens infested with lice are uncomfortable, finally become emaciated, and cannot be expected to thrive or to lay well. Everything around the fowls should be kept as clean as possible.

(*b*) *Water dishes and water* — For furnishing water to fowls some one of the many forms of fountains, among which those made of galvanized

iron are probably cheapest in the end, should be employed. Whatever style of water dish is used should be rinsed every day and washed at least once a week. Fresh water should always be supplied and the best poultrymen change the supply twice daily. The water dishes should be so placed that the hens will not scratch them full of dirt, and yet not so high that they cannot be reached easily by the fowls. If the long house with a passage in the rear is used, the water dishes should be so placed that they can be reached from the passage.

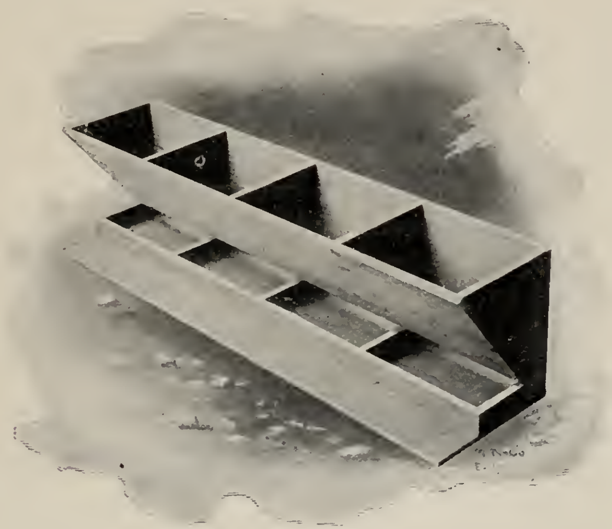


Fig. 282. Shell and Grit Boxes.

(*c*) *Grit* — As a foundation, houses for laying fowls should receive a layer of fresh sand or gravel as often, at least, as twice yearly — fall and spring. This will probably furnish all the grit or pebbles needed, but if the material does not contain good, sharp grit then the fowls should be supplied with artificial grit, otherwise they fail to digest their food thoroughly. The grit should be kept in a box where it will not become fouled, but where the birds can easily reach it.

(*d*) *Oyster shells* — Laying hens should have all the oyster shells they will eat. Unless they are laying, these are not required.

(*e*) *Charcoal* — It is desirable always to keep broken charcoal where fowls and chickens can reach it, as it appears to exercise a very favorable influence upon the health.

839. *Feeding laying hens* — There is still much diversity of opinion as to the proper method of feeding for eggs.

Boyer's method — Boyer says put all kitchen scraps into an old kettle and cook every evening, adding salt. In the morning heat a second time and scald with the scraps one pint of bran and one pint of a mixture of equal parts corn meal and ground oats. To this add a small quantity of scraps. The mash when completed should be dry and crumbly. Of this mash give in the morning about 2 quarts, rather less than more, to twelve hens. At noon feed 1 pint of wheat or oats in the straw. At night feed mixed grain. As a winter mixture he recommends equal parts wheat, oats, corn, and buckwheat, but advises reducing the corn one-half in summer. Boyer further advises adding to the mash a little condition powder or charcoal and sulfur twice a week. The writer most decidedly advises against the use of condition powders. His experiments have convinced him they are useless.

Buffington's method — Buffington recommends feeding in the morning a mash composed of equal parts of corn meal and middlings and a small quantity of beef scraps. In winter boiled potatoes may be added to this and the mash should be salted. This mash should be mixed with hot water and fed as soon as the fowls leave the roosts, except in summer. The quantity of mash given is a little less than sufficient to satisfy the appetite. A little dry grain is scattered afterwards in the straw. He recommends feeding in the afternoon dry grain, oats, corn, and wheat in equal parts.

The writer has had excellent success in feeding for eggs by the method which will be clearly understood from what follows: —

The number of fowls in a coop, 20; from October 25 to April 27, foods used as follows: —

Millet seed,	56 lbs.
Wheat bran,	42 "
Animal meal,	42 "
Cut clover rowen,	40 "

Corn meal,	111 lbs.
Corn,	408 "
Cabbages,	146 "

All the meals and the cut clover were mixed dry and fed in the form of a mash, scalded the evening before and fed early in the morning. At noon a little millet was scattered in the straw in the scratching sheds. At night the balance of the whole grain was fed, about an hour before dark, this also being scattered in the straw. In feeding it was the aim to give the fowls what they would eat up clean. The usual care was taken as regards water, shells, artificial grit, cleanliness, etc.

In summer the same coop of fowls, in a period extending from May 1st to Sept. 27th, consumed the following foods : —

Millet seed,	10 lbs.
Wheat bran,	49 "
Meat meal,	49 "
Corn meal,	129½ "
Corn,	368 "

The foods were divided and given as in the winter period. In place of the clover rowen and cabbages, the fowls received lawn clippings three times a week. They were kept in close confinement, both in winter and summer, but gave very satisfactory returns in eggs. It will be noticed that more corn and corn meal are included in these rations than most recommend. The writer, however, is convinced that corn is one of the cheapest and at the same time one of the best foods for laying fowls, provided it is fed with judgment. If given in excess or under conditions in which the fowls are allowed to become sluggish and inactive, they will, no doubt, become overfat and fail to give satisfactory returns in eggs.

840. *Should the mash be given in the morning or in the evening?* — Of late the question as to whether the mash should be given in the morning or in the evening has received considerable discussion. It is claimed, on the part of those who believe feeding the mash in the evening is better, that the fowls are more likely to become sluggish after a feed of mash than when fed whole grain, where the latter is scattered in the straw ; and that, as

activity is essential to health and good egg production, it must, therefore, be best to keep the hens working for whole grain during the day and give them the mash just before they go to roost. The Experiment Station of the Massachusetts Agricultural College has begun an investigation intended to throw light upon this question. The results so far obtained, which have not been fully published, are rather indecisive. It is found, however, that the quantity of droppings beneath the roosts, even during that period of the year when days and nights are of about equal length, is fully twice as great where the mash is fed at night as when whole grain is fed at night. Digestion evidently goes on with great rapidity and the digestive organs in the long winter nights must be, it would seem, comparatively empty long before morning. It may be that this is not undesirable, but the writer hazards the opinion that it will be found on the whole best to give the mash in the morning, but of course with the precaution not to give it in such quantities that the fowls fairly gorge themselves. They should leave the feeding trough with considerable appetite still remaining, under which circumstances they will work away busily in the straw to find whatever small quantity of grain may have been left from the night's feed.

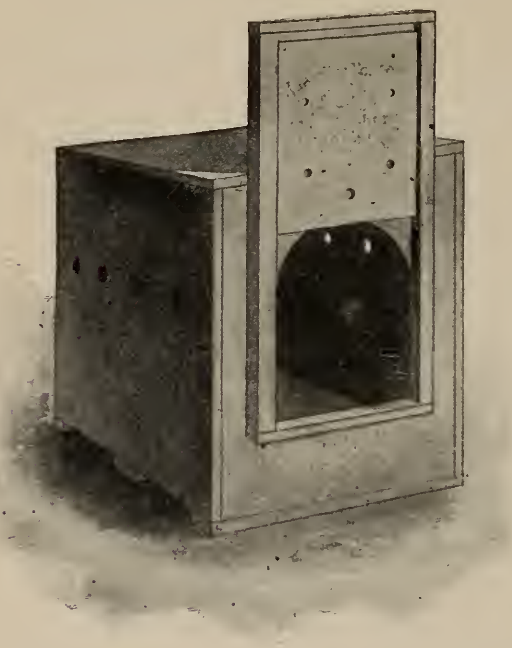


FIG. 283. NEST-BOX FOR DETERMINING THE BEST LAYERS.

841. *Breeding for eggs* — Until recently there has been no way of

telling just which hens in the flock laid the eggs, nor how many each laid in a year. A nest has been perfected in the Maine Agricultural College Experiment Station which enables the poultryman to determine just which hens lay. This nest is so constructed that the hen after she enters it must remain inside until let out by the attendant, who of course records her number and marks the egg at the same time. This nest is not patented. There are a number of patented nests upon the market which accomplish a similar result. There can be no doubt that if chickens be raised exclusively from the eggs of the fowls which are most productive the laying qualities can be greatly developed and increased within a few years.

842. *Methods of preventing disease* — Robinson in *Poultrycraft* gives the following hints : —

"(*a*) *Good care* — Good care should be the main factor depended upon for the avoidance of disease. This means providing in the first place a suitable location, good houses, well made, opened or closed according to the weather and temperature, good sanitary conditions in every respect, proper food, exercise, cleanliness.

"(*b*) *Quarantine* — Whenever fowls are purchased keep them by themselves as long as there is danger of their contracting diseases from one's own stock or transmitting them to old stock.

"(*c*) Prevent outside flocks from coming in contact with members of one's own flock or even feeding on the same ground. Pigeons also should be kept away. 'They are,' says Robinson, 'the worst disease mongers of all domestic birds.'

"(*d*) *Promptly care for all fowls which seem the least indisposed* — Correct wrong conditions as soon as they are noticed. Too often corrective measures are neglected until the disease has positively developed. It may not be possible to prevent disease entirely but a large share of it can be prevented."

CXLIV — TURKEYS.

843. *General considerations* — The turkey is the favorite table fowl in the United States. Good turkeys are always in demand and bring good

prices in the Eastern markets. It has become increasingly difficult to rear them in the older sections of the country. In some parts of New England where they were formerly common, a flock of turkeys is now seldom seen.

844. *Breeds of turkeys* — There are comparatively few breeds of turkeys. The Bronze is the largest, hardiest, and most popular, and usually the most profitable. Adult cocks may weigh about 36 pounds; hens, 20 pounds. The hens are poor layers. The Narragansett ranks next to the Bronze in size and in popularity. The weight of the adult cock is about 30 pounds, that of the hen 18 pounds. Slate, Buff, and Black turkeys are not generally popular. They are from 2 to 3 pounds lighter than the Narragansett. The White Holland is the smallest breed, the cock weighing about 26 pounds, the hen 16 pounds. The cross between the Wild turkey and the Bronze produces a very desirable fowl. They easily become wild if mismanaged. If properly handled they are as quiet in their habits as the ordinary domestic breeds.

Fig. 284. Pair of Bronze Turkeys.

845. *Selection of location for raising turkeys* — For success in turkey raising considerable space is required. The locality should be one with abundance of well-drained land. Pastures and mowings afford desirable ranges. Turkeys in many instances secure their entire living by foraging.

Fig. 285. Wild Gobbler.
By courtesy of Rhode Island Ex. Station.

846. *General care of turkeys* — Turkeys after they are half or more

grown require but little shelter. Adult fowls often roost in the open air all winter, and experiments at the Rhode Island Experiment Station indicated that they did better when roosting in open sheds than when more closely confined at night. The turkey hen is disposed to secrete her nest if possible. She can often be tempted to lay near the homestead by provision of good nesting places, such as old barrels turned on the side placed under a clump of shrubbery, heaps of brush, etc. It is very desirable that the nest be near the homestead. It then becomes possible to give whatever care may be needed. Newly hatched turkeys are very delicate. For the first six weeks they should be kept out of tall grass if wet, or they are very likely to become chilled and die. Sudden showers not infrequently kill many of them. It is best that they be driven to shelter before showers come up. As the turkey hen is almost certain to range widely, some prefer placing her in a coop, allowing the young only to range outside the coop. If this is done the coop should be frequently moved to fresh ground. The food of the young birds should be soft and easily digested. Hard boiled eggs may be used in moderation. In connection with them stale bread dipped in milk and allowed to become dry enough to crumble is excellent. The writer has had excellent success by the use of bread made from a mixture of corn meal, wheat bran or middlings in the proportion of about two parts of the corn to one of the bran or middlings with a little finely minced meat. The bread is mixed stiff with milk and baked. After the young birds are some six or seven weeks old, if they have done well up to that time, they become quite hardy and may be fed upon any of the foods suitable for chickens. They should then be given great freedom of range, and will need little, if any, protection from the weather.

CXLV—DUCKS.

847. *General considerations* — The business of raising ducks as table fowls has enormously increased within the past twenty-five years. Some of the very largest establishments engaged in any branch of poultry farming make the production of ducks a specialty. Ducks are comparatively easily raised and the business appears to be quite profitable.

CXLVI — BREEDS OF DUCKS.

848. *Pekin ducks* — The Pekin duck is white and is the best market duck. The body is very long and deep, the legs and toes of a reddish orange color. It is easily grown, it is hardy and does well in close con-

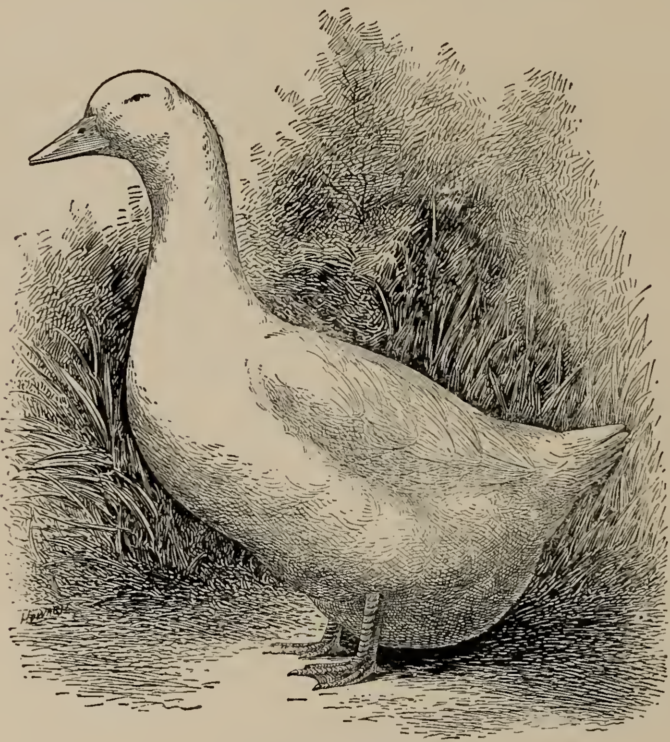


FIG. 286. PEKIN DUCK.
By courtesy of D. E. Salmon, Chief Bureau of Animal Industry, U. S. Dept. of Agriculture.

finement. The females are prolific layers of large white eggs. The adult drake should weigh about 8 pounds, females 7 pounds, the young drake or female one pound less.

849. *Aylesbury* — The Aylesbury duck resembles the Pekin though the body is more oval, plumage whiter but not so soft, legs and bill lighter yellow. The standard weight is one pound heavier than that of the Pekin. This breed is not as popular in America as the latter.

850. *Rouen* — Rouen ducks have dark colored plumage. This is

against the breed for market, as the dressed fowl does not present so attractive an appearance. Rouen ducks are quick growers and excellent for home use. They reach about the same weights as the Aylesbury.

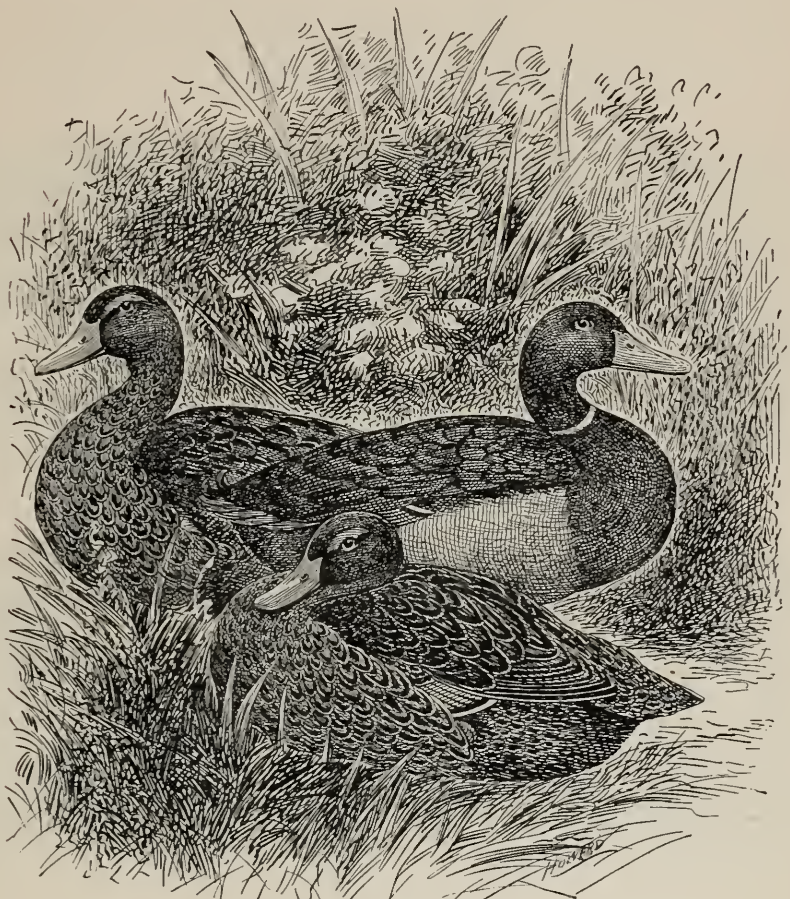


Fig. 287. Trio of Rouen Ducks.
By courtesy of D. E. Salmon, Chief Bureau of Animal Industry, U. S. Dept. of Agriculture.

851. Cayuga and Muscovy are other breeds kept somewhat in America but they have not nearly the importance of those described. Call ducks are diminutive in size, gray and white in color, kept only in fancy fowls.

Black-faced Indian ducks are small, black, and these also are kept for ornamental purposes. The Indian Runner is a small variety noted for egg production. The color is light fawn or gray shading to white. The weight of the drake is about 4½ pounds.

852. *General care and management* — Wherever ducks are kept for profit they are commonly raised upon a very large scale. They are kept

FIG. 288. DUCKLINGS NINE WEEKS OLD. Average weight, 2 pounds. Vegetable food only for part of the time Half of the number died before other food was supplied.
By courtesy of New York Experiment Station

FIG. 289. DUCKLINGS NINE WEEKS OLD. Average weight, 4.2 pounds. The ration contained animal food. No loss. *By courtesy of New York Experiment Station.*

in yards with fences about 2½ feet high. They are fed mostly on a moderately soft mash and green food. Green rape is excellent. Animal food is highly useful. Duck houses may be similar in construction to those for hens but should be larger. A greater number of ducks can be raised

in a flock. When kept to produce eggs for breeding not more than five females to the male should be the rule, in the early part of the season ; later, eight or ten The floor of the pen should be kept covered with clean straw. The eggs are commonly laid on the floor. The pens require to be cleansed often. Only breeders are allowed access to water for swimming. Ducks are very free from disease and are easily raised by artificial methods.

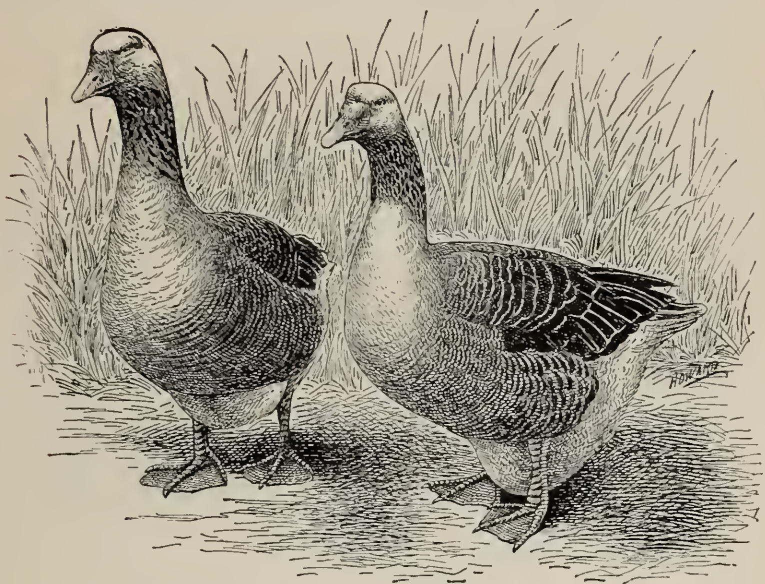


FIG. 290. PAIR OF GRAY TOULOUSE GEESE.
By courtesy of D. E. Salmon, Chief Bureau of Animal Industry, U. S. Dept. of Agriculture.

CXLVII — GEESE.

853. *Leading breeds. Toulouse* — This is the largest of the breeds of geese, often exceeding the standard weights, which are : adult gander 20, young gander 18, adult goose 18, young goose, 15 pounds. The color is grayish, the bill and legs reddish orange. In disposition these geese are quiet. The females are good layers, usually producing from thirty to forty eggs in a season.

Embden geese — The standard weights for Embden geese are the same as for Toulouse, but they generally run somewhat smaller. The females are

poor layers. Embden geese dress better for market than Toulouse, but have not become popular in the New England states.

African geese — The standard weights are the same as for Toulouse; color gray, beak black. Females are fair layers. These geese are said to be difficult to dress. The breed is rare in this country.

Fig. 291. Pair of White Embden Geese.
By courtesy of D. E. Salmon, Chief Bureau of Animal Industry, U. S. Dept. of Agriculture.

Chinese geese — Geese of this breed are somewhat smaller than the African, but resemble them to a considerable extent. Standard weights are: adults, gander 14, goose 12 pounds. There are two varieties, White and Brown. The females of the Brown variety are said to be great layers. The beak of the White variety is yellow.

Wild or Canada goose — The Wild or Canada goose has been domesticated to a considerable extent though there are still enormous flocks wild on the American continent. Wild geese resemble the swan in habit and structure much more nearly than do the other breeds of geese. In weight the Canada goose is about the same as the Chinese. The color is dark gray, beautifully shaded. Legs and beak are black. Canada geese are used to a considerable extent for crossing on domestic geese, producing hybrids which furnish better table fowls than pure domestic breeds. Canada geese are also kept for ornament and in some sections to a considerable extent as decoys for wild flocks.

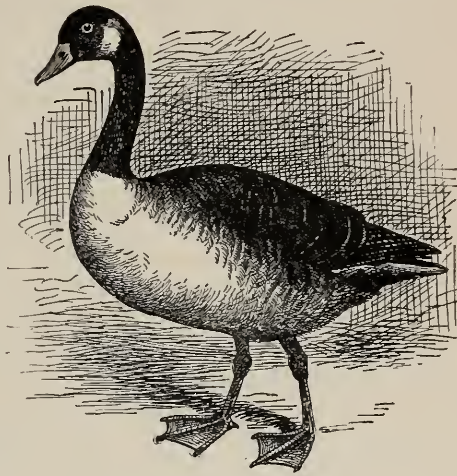


Fig. 292. Gray Wild Goose.
By courtesy of D. E. Salmon, Chief Bureau of Animal Industry, U. S. Dept. of Agriculture.

Egyptian geese — These are to be ranked as ornamental fowls. They are small, adult gander about 10 pounds, adult goose 8 pounds. Colors black, gray, and buff. The legs are reddish yellow.

854. *General management of geese* — Geese should be hatched either by the common hen or by the goose. Success by artificial means is difficult of attainment. The young need great care for a week, then they can care largely for themselves. It will be found best to keep them in meadows with water. They will need no other feed if the pasture is good. They, however, require a good range. For breeding purposes one male to four females is the usual proportion. The goose is not used to nearly so great an extent as a table fowl as are turkeys or ducks, but the demand for them when young (green geese) and during the holiday season, especially at Christmas, has increased considerably of late years and has become quite extensive. A farm having a suitable meadow might, under many circumstances, find a small flock of geese easily cared for and quite profitable.

Appendix

*Taken with few corrections to bring to date from list published by Prof. I. P. Roberts, Cornell University.

TABLE I.—FEEDING STANDARDS.

Amounts of Nutrients Required per Day.

Wolff-Lehman Standards from Mentzel and Lengerke, Farmers' Calendar.

	Live Weight. Pounds.	Total Dry Matter. Pounds.	DIGESTIBLE NUTRIENTS.			Nutritive Ratio 1:
			Protein. Pounds.	Carbohydrates. Pounds.	Fat. Pounds.	
Oxen:—						
At rest in stall	1,000	18	0.7	8.0	0.1	11.8
At light work	1,000	22	1.4	10.0	0.3	7.7
At medium work	1,000	25	2.0	11.5	0.5	6.5
At heavy work	1,000	28	2.8	13.0	0.8	5.3
Fattening Cattle:—						
First period	1,000	30	2.5	15.0	0.5	6.5
Second period	1,000	30	3.0	14.5	0.7	5.4
Third period	1,000	26	2.7	15.0	0.7	6.2
Milch Cows:—						
When yielding daily						
11 pounds milk	1,000	25	1.6	10.0	0.3	6.7
16.5 " "	1,000	27	2.0	11.0	0.4	6.0
22 " "	1,000	29	2.5	13.0	0.5	5.7
27.5 " "	1,000	32	3.3	13.0	0.8	4.5
Sheep:—						
Coarse wool	1,000	20	1.2	10.5	0.2	9.1
Fine wool	1,000	23	1.5	12.0	0.3	8.5
Breeding Ewes:—						
With lambs	1,000	25	2.9	15.0	0.5	5.6
Fattening Sheep:—						
First period	1,000	30	3.0	15.0	0.5	5.4
Second period	1,000	28	3.5	14.5	0.6	4.5

TABLE I.—*Continued.*

	Average Live Weight Per Head. Pounds.	Total Dry Matter. Pounds.	Digestible Nutrients. Protein. Pounds.	Carbohydrates. Pounds.	Fat. Pounds.	Nutritive Ratio 1:
GROWING SHEEP.						
Wool Breeds: —						
Age 4–6 months........	60	25	3.4	15.4	0.7	5.0
" 6–8 "	75	25	2.8	13.8	0.6	5.4
" 8–11 "	85	23	2.1	11.5	0.1	6.0
" 11–15 "	90	22	1.8	11.2	0.4	7.0
" 15–20 "	100	22	1.5	10.8	0.3	7.7
Mutton Breeds: —						
Age 4–6 months........	65	26	4.4	15.5	0.9	4.0
" 6–8 "	85	26	3.5	15.0	0.7	4.8
" 8–11 "	100	24	3.0	14.3	0.5	5.2
" 11–15 "	120	23	2.2	12.6	0.5	6.3
" 15–20 "	150	22	2.0	12.0	0.4	6.5
GROWING SWINE.						
Breeding Stock: —						
Age 2–3 months........	45	44	7.6	28.0	1.0	4.0
" 3–5 "	100	35	5.0	23.1	0.8	5.0
" 5–6 "	120	32	3.7	21.3	0.4	6.0
" 6–8 "	175	28	2.8	18.7	0.3	7.0
" 8–12 "	265	25	2.1	15.3	0.2	7.5
Fattening Stock: —						
Age 2–3 months........	45	44	7.6	28.0	1.0	4.0
" 3–5 "	110	35	5.0	23.1	0.8	5.0
" 5–6 "	145	33	4.3	22.3	0.6	5.5
" 6–8 "	200	30	3.6	20.5	0.4	6.0
" 8–12 "	290	26	3.0	18.3	0.3	6.4
Horses: —	Live Weight Pounds.					
At light work.........	1,000	20	1.5	9.5	0.4	7.0
At moderate work.....	1,000	24	2.0	11.0	0.6	6.2
At heavy work........	1,000	26	2.5	13.3	0.8	6.0
Brood Sows: —						
With pigs............	1,000	22	2.5	15.5	0.4	6.6
Fattening Swine: —						
First period..........	1,000	36	4.5	25.0	0.7	5.9
Second period........	1,000	32	4.0	24.0	0.5	6.3
Third period..........	1,000	25	2.7	18.0	0.4	7.0
GROWING CATTLE.	Average Live Weight Per Head. Pounds.					
Dairy Breeds:—						
Age 2–3 months........	150	23	4.0	13.0	2.0	4.5
" 3–6 "	300	24	3.0	12.8	1.0	4.1
" 6–12 "	500	27	2.0	12.5	0.5	6.8
" 12–18 "	700	26	1.8	12.5	0.4	7.5
" 18–24 "	880	26	1.5	12.0	0.3	8.5

TABLE I.—*Continued.*

	Average Live Weight Per Head. Pounds.	Total Dry Matter. Pounds.	Digestible Nutrients. Protein. Pounds.	Digestible Nutrients. Carbohydrates. Pounds.	Digestible Nutrients. Fat. Pounds.	Nutritive Ratio. 1 :
BEEF BREEDS.						
Age 2–3 months........	165	23	4.2	13.0	2.0	4.2
" 3–6 "	330	24	3.5	12.8	1.5	4.7
" 6–12 "	550	25	2.5	13.2	0.7	6.0
" 12–18 "	750	24	2.0	12.5	0.5	6.8
" 18–24 "	935	24	1.8	12.0	0.4	7.2
CONNECTICUT (STORRS) STANDARDS.						
Milch Cows: —	Live Weight. Pounds.					
When giving daily						
10–20 pounds milk	700–950	20–22	2.0	10–12	0.3–0.5	6.0
20–25 " "	700–950	21–23	2.3	10–12	0.4–0.6	5.3
25–30 " "	700–950	21–23	2.6	10–12	0.4–0.6	4.7
30–35 " "	700–950	22–24	2.9	11–13	0.5–0.7	4.6
35–40 " "	700–950	22–24	3.2	11–13	0.5–0.7	4.2
10–20 " "	950–1,100	22–24	2.3	12–14	0.4–0.6	6.1
20–25 " "	950–1,100	23–25	2.6	12–14	0.5–0.7	6.5
25–30 " "	950–1,100	23–25	2.9	12–14	0.5–0.7	5.0
30–35 " "	950–1,100	24–26	3.2	13–15	0.6–0.8	4.9
35–40 " "	950–1,100	24–26	3.5	13–15	0.6–0.8	4.4
WISCONSIN STANDARD.						
Average (128 herds).....	1,000	24.51	2.15	13.27	0.74	6.9

Table II.—Feeding Stuffs Most Commonly Used in Cattle Feeding in the New England and Middle States.

Average Composition and Percentage of Digestible Ingredients.*

Digestibility of some foods approximated on basis of known digestibility of food stuff most nearly resembling such foods.

* Condensed by permission from tables in Bulletin 81, Vermont Experiment Station.

—*Courtesy of Prof. J. L. Hills.*

FODDERS.	Total Food Constituents. Percentages.						Digestible Ingredients. Percentages.				
	Water.	Crude ash.	Crude protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Dry matter.	Crude protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.
Roughages.											
Green Fodders:—											
Pasture grass	80.0	2.0	3.5	4.0	9.7	0.8	13.8	2.3	3.0	7.1	0.4
Timothy	61.6	2.1	3.1	11.8	20.2	1.2	24.6	1.5	6.6	13.3	0.6
Redtop	65.3	2.3	2.8	11.0	17.7	0.9	22.2	1.3	6.2	11.7	0.5
Kentucky blue grass (June grass)	65.1	2.8	4.1	9.1	17.6	1.3	22.3	2.0	5.1	11.6	0.7
Rowen	70.1	2.4	4.5	7.6	13.7	1.7	19.4	3.2	4.8	9.6	0.9
Fodder corn	79.3	1.2	1.8	5.0	12.2	0.5	14.1	1.1	3.0	9.0	0.4
Sweet fodder corn	79.1	1.3	1.9	4.4	12.8	0.5	14.8	1.2	2.8	9.9	0.4
Barley fodder	75.2	2.0	3.4	6.5	12.0	0.9	16.4	2.4	4.0	8.5	0.5
Oat fodder	62.2	2.5	3.4	11.2	19.3	1.4	22.7	2.4	5.9	12.0	1.0
Rye fodder	76.6	1.8	2.6	11.6	6.8	0.6	17.1	2.1	9.2	4.8	0.5
Hungarian	71.1	1.7	3.1	9.2	14.2	0.7	19.4	2.0	6.5	9.7	0.5
Oats and peas	78.7	1.7	3.5	6.0	9.1	1.0	13.8	2.7	3.6	6.2	0.7
Barley and peas	79.4	1.8	3.7	5.2	9.1	0.8	10.9	2.8	2.3	5.6	0.5
Red clover	70.8	2.1	4.4	8.1	13.5	1.1	19.3	2.9	4.3	10.5	0.7
Alsike clover	74.8	2.0	3.9	7.4	11.0	0.9	16.6	2.6	3.9	8.6	0.6
Clover rowen	75.0	2.1	4.6	6.2	11.0	1.1	14.8	2.9	3.3	7.2	0.7
Hays and Dry Fodders:—											
Mixed hay	15.3	5.5	7.4	27.2	42.1	2.5	48.3	4.4	16.3	24.8	1.2
Timothy	13.2	4.4	5.9	29.0	45.0	2.5	49.5	2.8	15.4	27.9	1.3
Redtop	8.9	5.2	7.9	28.6	47.5	1.9	54.7	4.8	17.4	29.5	1.0
Kentucky blue grass (June grass)	26.1	6.7	6.1	24.1	33.7	3.3	44.3	3.7	14.7	20.9	1.7
Rowen, mixed	16.6	6.8	11.6	22.5	39.4	3.1	53.4	8.0	15.1	26.0	1.5
Rowen, fine	13.1	6.5	14.0	24.4	38.3	3.7	55.6	9.7	16.3	25.3	1.7
Corn fodder	42.2	2.7	4.5	14.3	34.7	1.6	39.3	2.5	8.0	25.0	1.2
Corn stover	40.1	3.4	3.8	19.8	31.8	1.1	34.1	1.4	12.7	18.4	0.8
Oat hay	8.9	6.2	7.6	29.3	45.1	2.9	43.9	4.1	12.9	23.5	1.8
Oat and pea hay	11.5	6.6	14.8	24.9	38.9	3.3	57.5	11.2	14.9	26.5	2.2
Hungarian	16.5	5.6	8.2	22.6	43.9	3.2	54.3	4.9	15.4	29.4	2.0
Red clover hay	15.3	6.2	12.3	24.8	38.1	3.3	48.3	7.1	13.4	24.4	1.8
Alsike clover hay	9.7	8.3	12.8	25.6	40.7	2.9	56.0	8.4	13.8	28.9	1.5
Clover rowen hay	8.3	7.1	13.1	31.3	37.9	2.3	53.2	8.5	14.7	23.9	1.4
Barley straw	14.2	5.7	3.5	36.0	39.0	1.5	45.5	0.7	20.2	21.1	0.6
Oat straw	9.2	5.1	4.0	37.0	42.4	2.3	45.4	1.2	21.5	22.5	0.9
Wheat straw	9.6	4.2	3.4	38.1	43.4	1.3	38.9	0.4	19.8	16.5	0.4
Rye straw	7.1	3.2	3.0	38.9	46.6	1.2	42.7	0.6	23.3	17.2	0.4

TABLE II—*Continued.*

FODDERS.	Total Food Constituents. Percentages.						Digestible Ingredients. Percentages.				
	Water.	Crude ash.	Crude protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Dry matter.	Crude protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.
ROUGHAGES—*Continued.*											
Silages and Roots:—											
Corn silage (mature corn)	73.7	1.6	2.2	6.5	15.1	0.9	18.7	1.2	4.6	11.5	0.7
Corn silage (immature corn)	79.1	1.4	1.7	6.0	11.0	0.8	13.8	0.9	4.3	7.4	0.6
Corn silage (ears plucked off)	80.7	1.8	1.8	5.6	9.5	0.6	11.0	0.6	3.6	5.5	0.4
Clover silage	72.0	2.6	4.2	8.4	11.6	1.2	16.2	2.7	3.9	7.3	0.7
Potatoes	78.9	1.0	2.1	0.6	17.3	0.1	16.0	0.9	—	15.6	0.0
Beets	88.5	1.0	1.5	0.9	8.0	0.1	10.9	1.4	0.9	8.0	0.1
Sugar beets	86.5	0.9	1.8	0.9	9.8	0.1	12.8	1.6	0.9	9.8	0.1
Carrots	88.6	1.0	1.1	1.3	7.6	0.4	10.6	1.0	1.3	7.4	0.4
Mangel-wurzels	90.9	1.1	1.4	0.9	5.5	0.2	7.2	1.1	0.4	5.0	—
Ruta-bagas	88.6	1.2	1.2	1.3	7.5	0.2	9.9	1.0	1.0	7.1	0.2
Turnips	90.5	0.8	1.1	1.2	6.2	0.2	8.8	1.0	1.2	6.0	0.2
Miscellaneous:—											
Apples	80.7	0.4	0.7	1.2	16.6	0.4	—	—	—	—	—
Apple pomace	76.7	0.5	1.4	3.9	16.2	1.3	—	—	—	—	—
Pumpkins	90.9	0.5	1.3	1.7	5.2	0.4	—	—	—	—	—
Skim milk	90.6	0.7	3.1	—	5.3	0.3	9.2	2.9	—	5.2	0.3
Buttermilk	90.1	0.7	4.0	—	4.0	1.1	9.7	3.8	—	3.9	1.1
Whey	93.8	0.4	0.6	—	5.1	0.1	6.1	0.6	—	5.0	0.1
CONCENTRATES.											
Grains and By-Products:—											
Corn meal	15.0	1.4	9.2	1.9	68.7	3.8	75.7	6.3	—	65.3	3.5
Corn and cob meal	15.1	1.5	8.5	6.6	64.8	3.5	67.1	4.8	3.0	57.0	2.9
Oats	11.0	3.0	11.8	9.5	59.7	5.0	62.3	9.2	1.9	45.4	4.2
Provender (½ corn, ½ oats)	13.0	2.2	10.5	5.7	64.2	4.4	69.6	7.7	0.6	55.2	3.9
Provender (as sold in New Eng.)	11.6	2.6	9.3	8.0	64.7	3.8	70.7	6.8	0.8	55.6	3.3
Oat hulls	7.3	6.7	3.3	29.7	52.1	1.0	64.9	2.6	5.9	39.6	0.8
Quaker dairy feed	8.3	5.0	13.4	16.8	52.8	3.7	56.9	10.9	7.2	35.4	3.3
H. O. dairy feed	8.8	3.8	18.9	13.3	51.2	4.0	59.3	14.7	5.5	35.8	3.4
Victor corn and oat feed	9.9	4.0	8.9	12.8	60.6	3.8	67.6	6.3	6.1	50.3	3.3
H. O. horse feed	9.9	3.1	12.4	10.1	60.4	4.1	63.1	9.2	3.5	47.7	3.4
Barley	10.9	2.4	12.4	2.7	69.8	1.8	76.6	8.7	1.4	64.2	1.6
Barley screenings	12.2	3.6	12.3	7.3	61.8	2.8	75.5	8.6	3.7	56.9	2.5
Wheat	10.5	1.8	11.9	1.8	71.9	2.1	—	—	—	—	—
Wheat bran	11.9	5.8	15.4	9.0	53.9	4.0	54.6	12.0	2.6	37.2	2.7
Wheat middlings	12.1	3.3	15.6	4.6	60.4	4.0	65.9	12.5	1.5	48.9	3.4
Wheat screenings	11.6	2.9	12.5	4.9	65.1	3.0	54.8	9.8	1.4	44.9	2.0
Mixed (wheat) feed	10.8	5.5	16.8	7.4	54.8	4.7	61.5	13.3	2.3	41.1	3.6
Red dog flour	9.0	3.8	22.2	1.9	57.4	5.7	68.3	17.8	0.6	46.5	4.9
Rye	11.6	1.9	10.6	1.7	72.5	1.7	76.9	8.9	—	66.7	1.1
Rye bran	11.6	3.6	14.7	30.5	63.8	2.8	76.9	12.3	—	58.7	1.8

TABLE II.—*Continued.*

FODDERS.	Total Food Constituents. Percentages. Water.	Crude ash.	Crude protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Digestible Ingredients. Percentages. Dry matter.	Crude protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.
CONCENTRATES—*Continued.*											
Grains and By-Products:—											
Buckwheat	12.6	2.0	10.0	8.7	64.5	2.2	—	—	—	—	—
Buckwheat hulls	11.6	2.8	5.6	35.0	43.4	1.6	—	—	—	—	—
Buckwheat bran	10.5	3.0	12.4	31.9	38.8	3.3	—	—	—	—	—
Buckwheat middlings	11.5	4.5	27.5	4.2	45.3	7.0	—	—	—	—	—
Cottonseed meal	8.3	6.9	45.4	5.5	22.7	11.2	67.9	40.0	3.1	13.8	10.4
Cottonseed feed	11.7	3.1	12.0	31.0	39.1	3.1	58.3	7.9	16.1	21.9	2.8
Cottonseed hulls	11.1	2.8	4.2	46.3	33.4	2.2	35.6	—	18.5	13.7	1.9
Linseed meal (old process)	9.9	5.8	34.6	8.1	34.1	7.5	71.2	30.8	4.6	26.6	6.7
Linseed meal (new process)	10.7	5.6	38.1	8.2	34.8	2.6	70.5	32.4	6.6	29.9	2.5
Flax meal	11.4	5.1	37.8	8.8	33.4	3.5	70.0	32.1	7.0	28.7	3.4
Gluten meal (Chicago)	12.3	1.3	36.5	1.4	45.8	2.7	78.9	32.1	—	41.2	2.5
Gluten meal (Cream)	10.1	0.8	33.7	1.7	51.1	2.6	80.9	29.7	—	46.0	2.4
Gluten meal (King)	7.4	0.5	33.7	1.2	52.6	4.6	83.3	29.7	—	47.3	4.3
Gluten feed (Buffalo)	9.6	2.3	27.1	6.7	51.1	3.2	77.7	23.3	5.2	45.5	2.7
Gluten feed (Diamond or Rockford)	8.9	0.8	23.6	6.6	56.6	3.5	78.3	20.3	5.1	50.4	2.9
Hominy chop	8.4	2.6	11.3	4.9	64.9	7.9	82.4	8.7	4.0	61.7	6.4
Starch feed, wet	65.4	0.3	6.1	3.1	22.0	3.1	31.1	5.4	—	19.8	2.9
Dried brewers' grains	8.2	3.6	19.9	11.0	51.7	5.6	56.9	15.7	5.8	30.0	5.1
Atlas gluten meal	8.3	1.8	33.7	11.5	32.1	12.6	73.4	24.6	11.5	27.3	11.5
Malt sprouts	10.2	5.7	23.2	10.7	48.5	1.7	60.2	18.6	3.5	33.0	1.7
Pea meal	10.5	2.6	20.2	14.4	51.1	1.2	77.9	16.8	3.7	48.0	0.7

Table III.—Convenience Table.*

Pounds of total dry matter and digestible ingredients (protein and carbohydrates [including ether extract × 2.25]) in varying weights of fodders and feeds.

* Courtesy, Prof. J. L. Hills, Vt. Experiment Station, slightly modified from Bulletin 81.

Pounds of fodder	Total dry matter	Protein	Carbohydrates, etc.	Total dry matter	Protein	Carbohydrates, etc.	Total dry matter	Protein	Carbohydrates, etc.
Grasses	Pasture grass, 1 : 4.8			Timothy grass, 1 : 14.3			Redtop grass, 1 : 14.6		
2½	0.5	0.06	0.3	1.0	0.04	0.5	0.9	0.03	0.5
5	1.0	0.12	0.6	1.9	0.08	1.1	1.7	0.07	1.0
10	2.0	0.23	1.1	3.8	0.15	2.1	3.5	0.13	1.9
15	3.0	0.35	1.7	5.8	0.23	3.2	5.2	0.20	2.9
20	4.0	0.46	2.2	7.7	0.30	4.3	6.9	0.26	3.8
25	5.0	0.58	2.8	9.6	0.38	5.4	8.7	0.33	4.8
30	6.0	0.69	3.3	11.5	0.45	6.4	10.4	0.39	5.7
35	7.0	0.81	3.9	13.4	0.53	7.5	12.1	0.46	6.7
40	8.0	0.92	4.4	15.4	0.60	8.6	13.9	0.52	7.6
Grasses	Kentucky blue grass, 1 : 9.2			Green rowen, 1 : 5.1			Green fodder corn, 1 : 11.7		
2½	0.9	0.05	0.5	0.7	0.08	0.4	0.5	0.03	0.3
5	1.8	0.10	0.9	1.5	0.16	0.8	1.0	0.06	0.6
10	3.5	0.20	1.8	3.0	0.32	1.6	2.1	0.11	1.3
15	5.2	0.30	2.7	4.5	0.48	2.5	3.1	0.17	1.9
20	7.0	0.40	3.7	6.0	0.64	3.3	4.1	0.22	2.6
25	8.7	0.50	4.7	7.5	0.80	4.1	5.2	0.28	3.2
30	10.5	0.60	5.5	9.0	0.96	4.9	6.2	0.33	3.9
35	12.2	0.70	6.4	10.5	1.12	5.7	7.2	0.39	4.5
40	14.0	0.80	7.3	12.0	1.28	6.6	8.3	0.44	5.2
Green fodders	Sweet fodder corn, 1 : 11.3			Green barley fodder, 1 : 5.7			Green oat fodder, 1 : 8.7		
2½	0.5	0.03	0.3	0.6	0.06	0.3	0.9	0.06	0.5
5	1.0	0.06	0.7	1.2	0.12	0.7	1.9	0.12	1.0
10	2.1	0.12	1.4	2.5	0.24	1.4	3.8	0.24	2.1
15	3.1	0.18	2.1	3.7	0.36	2.1	5.7	0.36	3.1
20	4.2	0.24	2.7	5.0	0.48	2.7	7.6	0.48	4.2
25	5.2	0.30	3.4	6.2	0.60	3.4	9.5	0.60	5.2
30	6.3	0.36	4.1	7.4	0.72	4.1	11.3	0.72	6.2
35	7.3	0.42	4.8	8.7	0.84	4.8	13.2	0.84	7.3
40	8.4	0.48	5.4	9.9	0.96	5.4	15.1	0.96	8.3
Green fodders	Green rye fodder, 1 : 7.2			Green hungarian, 1 : 8.7			Oats and peas, 1 : 4.2		
2½	0.6	0.05	0.4	0.7	0.05	0.4	0.5	0.07	0.3
5	1.2	0.11	0.7	1.4	0.10	0.8	1.1	0.14	0.5
10	2.3	0.21	1.5	2.9	0.20	1.7	2.1	0.27	1.1
15	3.5	0.32	2.3	4.3	0.30	2.6	3.2	0.41	1.7
20	4.7	0.42	3.0	5.8	0.40	3.5	4.3	0.54	2.3
25	5.9	0.52	3.8	7.2	0.50	4.3	5.3	0.68	2.9
30	7.0	0.63	4.5	8.7	0.60	5.2	6.4	0.81	3.4
35	8.2	0.74	5.3	10.1	0.70	6.1	7.5	0.95	4.0
40	9.4	0.84	6.0	11.6	0.80	6.9	8.5	1.08	4.6

TABLE III.—*Continued.*

Pounds of fodder	Total dry matter	Protein	Carbohydrates, etc.	Total dry matter	Protein	Carbohydrates, etc.	Total dry matter	Protein	Carbohydrates, etc.
Green fodders	Barley and peas, 1 : 3.2			Red clover (green) 1 : 5.7			Alsike clover (green), 1 : 5.3		
2½	0.5	0.07	0.2	0.7	0.07	0.4	0.6	0.07	0.3
5	1.0	0.14	0.4	1.5	0.15	0.8	1.3	0.13	0.7
10	2.1	0.28	0.9	2.9	0.29	1.6	2.5	0.26	1.4
15	3.1	0.42	1.4	4.4	0.44	2.5	3.8	0.39	2.1
20	4.1	0.56	1.8	5.9	0.58	3.3	5.0	0.52	2.8
25	5.2	0.70	2.3	7.3	0.73	4.1	6.3	0.65	3.5
30	6.2	0.84	2.7	8.8	0.87	4.9	7.6	0.78	4.2
35	7.2	0.98	3.2	10.2	1.02	5.7	8.8	0.91	4.9
40	8.2	1.12	3.6	11.7	1.16	6.6	10.1	1.04	5.6
Green fodders and silages	Green clover rowen, 1 : 4.2			Corn silage (mature), 1 : 14.8			Corn silage (immature), 1 : 14.6		
2½	0.6	0.07	0.3	0.7	0.03	0.4	0.5	0.02	0.3
5	1.3	0.14	0.6	1.3	0.06	0.8	1.0	0.05	0.6
10	2.5	0.29	1.2	2.6	0.12	1.8	2.1	0.09	1.3
15	3.8	0.44	1.6	3.9	0.18	2.7	3.1	0.14	1.9
20	5.0	0.58	2.4	5.3	0.24	3.6	4.2	0.18	2.6
25	6.3	0.73	3.0	6.6	0.30	4.5	5.2	0.23	3.2
30	7.5	0.87	3.6	7.9	0.36	5.3	6.3	0.27	3.9
35	8.8	1.02	4.2	9.2	0.42	6.2	7.3	0.32	4.5
40	1.00	1.16	4.8	10.5	0.48	7.1	8.4	0.36	5.2
Silages, etc.	Corn stover silage, 1 : 16.6			Clover silage, 1 : 4.7			Potatoes, 1 : 17.3		
2½	0.5	0.02	0.3	0.7	0.07	0.3	0.5	0.02	0.4
5	1.0	0.03	0.5	1.4	0.14	0.6	1.1	0.05	0.8
10	1.9	0.06	1.0	2.8	0.27	1.3	2.1	0.09	1.6
15	2.9	0.09	1.5	4.2	0.41	1.9	3.2	0.14	2.3
20	3.9	0.12	2.0	5.6	0.54	2.6	4.2	0.18	3.1
25	4.8	0.15	2.5	7.0	0.68	3.2	5.3	0.23	3.9
30	5.8	0.18	3.0	8.4	0.81	3.9	6.3	0.27	4.7
35	6.8	0.21	3.5	9.8	0.95	4.5	7.4	0.32	5.4
40	7.7	0.24	4.0	11.2	1.08	5.1	8.4	0.36	6.2
Roots	Beets, 1 : 6.5			Sugar beets, 1 : 6.8			Carrots, 1 : 9.6		
2½	0.3	0.04	0.2	0.3	0.04	0.3	0.3	0.03	0.2
5	0.6	0.07	0.5	0.7	0.08	0.5	0.5	0.05	0.5
10	1.2	0.14	0.9	1.4	0.16	1.1	1.1	0.10	1.0
15	1.7	0.21	1.4	2.0	0.24	1.7	1.6	0.15	1.4
20	2.3	0.28	1.8	2.7	0.32	2.2	2.3	0.20	1.9
25	2.9	0.35	2.3	3.4	0.40	2.7	2.9	0.25	2.4
30	3.5	0.42	2.7	4.1	0.48	3.3	3.4	0.30	2.9
35	4.0	0.49	3.2	4.7	0.56	3.8	4.0	0.35	3.4
40	4.6	0.56	3.6	5.4	0.64	4.4	4.6	0.40	3.8

TABLE III.—*Continued.*

Pounds of fodder	Total dry matter	Protein	Carbohydrates, etc.	Total dry matter	Protein	Carbohydrates, etc.	Total dry matter	Protein	Carbohydrates, etc.
Roots	Mangel-wurzels, 1 : 4.9			Ruta-bagas, 1 : 8.6			Turnips, 1 : 7.7		
2½	0.2	0.03	0.1	0.3	0.03	0.2	0.2	0.03	0.2
5	0.4	0.06	0.3	0.5	0.05	0.4	0.5	0.05	0.4
10	0.9	0.11	0.5	1.1	0.10	0.9	1.0	0.10	0.8
15	1.4	0.17	0.8	1.6	0.15	1.3	1.4	0.15	1.2
20	1.8	0.22	1.1	2.3	0.20	1.7	1.9	0.20	1.5
25	2.3	0.28	1.4	2.9	0.25	2.2	2.4	0.25	1.9
30	2.7	0.33	1.6	3.4	0.30	2.6	2.9	0.30	2.3
35	3.2	0.39	1.9	4.0	0.35	3.0	3.3	0.35	2.7
40	3.6	0.44	2.2	4.6	0.40	3.4	3.8	0.40	3.1
Milk	Skim milk, 1 : 2.0			Buttermilk, 1 : 1.7			Whey, 1 : 8.7		
2½	0.2	0.07	0.1	0.2	0.10	0.2	0.2	0.02	0.1
5	0.5	0.15	0.3	0.5	0.19	0.3	0.3	0.03	0.3
10	0.9	0.29	0.6	1.0	0.38	0.6	0.6	0.06	0.5
15	1.4	0.44	0.9	1.5	0.57	1.0	0.9	0.09	0.8
20	1.9	0.58	1.2	2.0	0.76	1.3	1.2	0.12	1.0
25	2.4	0.73	1.6	2.5	0.95	1.6	1.5	0.15	1.3
30	2.8	0.87	1.8	3.0	1.14	1.9	1.9	0.18	1.6
35	3.2	1.02	2.1	3.5	1.33	3.2	2.2	0.21	1.8
40	3.7	1.16	2.4	4.0	1.52	2.6	2.5	0.24	2.1
Hays	Mixed hay, 1 : 10.0			Timothy hay, 1 : 16.5			Redtop hay, 1 : 10.3		
2½	2.1	0.11	1.1	2.2	0.07	1.2	2.3	0.12	1.2
5	4.2	0.22	2.2	4.3	0.14	2.3	4.6	0.24	2.4
7½	6.4	0.33	3.3	6.5	0.21	3.5	6.8	0.36	3.6
10	8.5	0.44	4.4	8.7	0.28	4.6	9.1	0.48	4.9
12½	10.6	0.55	5.5	10.9	0.35	5.8	11.4	0.60	6.2
15	12.7	0.66	6.6	13.0	0.42	6.9	13.9	0.72	7.4
17½	14.8	0.77	7.7	15.2	0.49	8.1	16.0	0.84	8.6
20	16.9	0.88	8.8	17.4	0.56	9.2	18.2	0.96	9.8
25	21.2	1.10	11.0	21.7	0.70	11.6	22.8	1.20	12.3
Hays	Kentucky blue grass hay, 1 : 10.6			Rowen hay (mixed), 1 : 5.6			Rowen hay (fine), 1 : 4.7		
2½	1.9	0.09	1.0	2.1	0.20	1.1	2.2	0.24	1.1
5	3.7	0.19	2.0	4.2	0.40	2.3	4.3	0.49	2.3
7½	5.6	0.28	3.0	6.3	0.60	3.4	6.5	0.73	3.4
10	7.4	0.37	3.9	8.3	0.80	4.5	8.7	0.97	4.6
12½	9.2	0.46	4.9	10.4	1.00	5.6	10.9	1.21	5.7
15	11.1	0.56	5.9	12.5	1.20	6.7	13.0	1.46	6.8
17½	13.0	0.65	6.9	14.6	1.40	7.8	15.2	1.70	8.0
20	14.8	0.74	7.9	16.7	1.60	8.9	17.4	1.94	9.1
25	18.5	0.93	9.9	20.9	2.00	11.2	21.7	2.43	11.4

TABLE III.—*Continued.*

Pounds of fodder	Total dry matter	Protein	Carbohydrates, etc.	Total dry matter	Protein	Carbohydrates, etc.	Total dry matter	Protein	Carbohydrates, etc.
Dry fodders	Corn fodder, 1 : 14.3			Corn stover, 1 : 23.6			Oat hay, 1 : 9.9		
2½	1.4	0.06	0.9	1.5	0.04	0.8	2.3	0.10	1.0
5	2.9	0.13	1.8	3.0	0.07	1.7	4.6	0.21	2.0
7½	4.3	0.19	2.7	4.5	0.11	2.5	6.8	0.31	3.0
10	5.8	0.25	3.6	6.0	0.14	3.3	9.1	0.41	4.0
12½	7.2	0.32	4.5	7.5	0.18	4.1	11.4	0.51	5.1
15	8.7	0.38	5.4	9.0	0.21	5.0	13.7	0.62	6.1
17½	10.1	0.44	6.2	10.5	0.25	5.8	16.0	0.72	7.1
20	11.6	0.50	7.1	12.0	0.28	6.6	18.2	0.82	8.1
25	14.5	0.63	8.9	15.0	0.35	8.3	22.8	1.03	10.2
Hays	Oat and pea hay, 1 : 4.1			Hungarian, 1 : 10.0			Red clover hay, 1 : 5.9		
2½	2.2	0.28	1.2	2.1	0.12	1.2	2.1	0.18	1.0
5	4.4	0.56	2.3	4.2	0.25	2.4	4.2	0.36	2.1
7½	6.6	0.84	3.5	6.3	0.37	3.6	6.4	0.53	3.2
10	8.9	1.12	4.6	8.4	0.49	4.9	8.5	0.71	4.2
12½	11.1	1.40	5.8	10.4	0.62	6.2	10.6	0.89	5.2
15	13.3	1.68	6.9	12.5	0.74	7.4	12.7	1.07	6.3
17½	15.5	1.96	8.1	14.6	0.86	8.6	14.8	1.24	7.3
20	17.7	2.24	9.2	16.7	0.98	9.8	16.9	1.42	8.3
25	22.1	2.80	11.6	20.9	1.23	12.3	21.2	1.78	10.5
Hays, etc.	Alsike clover hay, 1 : 5.5			Clover rowen hay, 1 : 4.9			Barley straw, 1 : 61.0		
2½	2.3	0.21	1.2	2.3	0.21	1.0	2.1	0.02	1.1
5	4.5	0.42	2.3	4.6	0.43	2.1	4.3	0.04	2.1
7½	6.8	0.63	3.5	6.9	0.64	3.2	6.4	0.05	3.2
10	9.0	0.84	4.6	9.2	0.85	4.2	8.6	0.07	4.3
12½	11.3	1.05	5.8	11.5	1.07	5.2	10.7	0.09	5.3
15	13.5	1.26	6.9	13.8	1.28	6.3	12.9	0.11	6.4
17½	15.8	1.47	8.1	16.0	1.49	7.3	15.0	0.12	7.5
20	18.1	1.68	9.2	18.3	1.70	8.3	17.2	0.14	8.5
25	22.6	2.10	11.6	22.9	2.13	10.5	21.5	0.18	10.7
Straws	Oat straw, 1 : 38.3			Wheat straw, 1 : 93.0			Rye straw, 1 : 69.0		
2½	2.3	0.03	1.2	2.3	0.01	0.9	2.3	0.02	1.0
5	4.6	0.06	2.3	4.5	0.02	1.9	4.6	0.03	2.1
7½	6.8	0.09	3.5	6.8	0.03	2.8	7.0	0.05	3.1
10	9.1	0.12	4.6	9.0	0.04	3.7	9.3	0.06	4.1
12½	11.4	0.15	5.8	11.3	0.05	4.6	11.6	0.08	5.2
15	13.9	0.18	6.9	13.5	0.06	5.6	13.9	0.09	6.2
17½	16.0	0.21	8.1	15.8	0.07	6.5	16.3	0.11	7.2
20	18.2	0.24	9.2	18.1	0.08	7.4	18.6	0.12	8.3
25	22.7	0.30	11.5	22.6	0.10	9.3	23.2	0.15	10.4

TABLE III.—*Continued.*

Pounds of fodder	Total dry matter	Protein	Carbohydrates, etc.	Total dry matter	Protein	Carbohydrates, etc.	Total dry matter	Protein	Carbohydrates, etc.
Grains	Corn meal, 1 : 11.3			Corn and cob meal, 1 : 13.9			Oats, 1 : 6.2		
¼	0.2	0.02	0.2	0.2	0.01	0.2	0.2	0.02	0.1
½	0.4	0.03	0.4	0.4	0.02	0.3	0.4	0.05	0.3
1	0.9	0.06	0.7	0.9	0.05	0.7	0.9	0.09	0.6
2	1.7	0.13	1.4	1.7	0.10	1.3	1.8	0.18	1.1
3	2.6	0.19	2.1	2.6	0.14	2.0	2.7	0.28	1.7
4	3.4	0.25	2.9	3.4	0.19	2.7	3.6	0.37	2.3
5	4.3	0.32	3.6	4.3	0.24	3.4	4.5	0.46	2.8
7½	6.4	0.48	5.4	6.4	0.36	5.1	6.7	0.69	4.3
10	8.5	0.63	7.1	8.5	0.48	6.7	8.9	0.92	5.7
Grains, etc.	Provender (½ ½) 1 : 8.4			Provender (as sold in New England), 1 : 9.4			Oat hulls, 1 : 18.2		
¼	0.2	0.02	0.2	0.2	0.02	0.2	0.2	0.01	0.1
½	0.4	0.04	0.3	0.4	0.03	0.3	0.5	0.02	0.3
1	0.9	0.08	0.6	0.9	0.07	0.6	0.9	0.03	0.5
2	1.7	0.15	1.3	1.8	0.14	1.3	1.9	0.05	0.9
3	2.6	0.23	1.9	2.7	0.20	1.9	2.8	0.08	1.4
4	3.5	0.31	2.6	3.5	0.27	2.5	3.7	0.10	1.9
5	4.4	0.39	3.2	4.4	0.34	3.2	4.6	0.13	2.4
7½	6.5	0.58	4.9	6.6	0.51	4.8	7.0	0.20	3.5
10	8.7	0.77	6.5	8.8	0.68	6.4	9.3	0.26	4.7
By-products	Quaker dairy feed, 1 : 4.6			H. O. dairy feed, 1 : 3.3			Victor corn and oat feed, 1 : 10.1		
¼	0.2	0.03	0.1	0.2	0.04	0.1	0.2	0.02	0.2
½	0.5	0.05	0.3	0.5	0.07	0.2	0.5	0.03	0.3
1	0.9	0.11	0 5	0.9	0.15	0.5	0.9	0.06	0.6
2	1.8	0.22	1.0	1.8	0.29	1.0	1.8	0.13	1.3
3	2.8	0.33	1.5	2.7	0.44	1.5	2.7	0.19	1.9
4	3.7	0.44	2.0	3.6	0.59	2.0	3.6	0.25	2.5
5	4.6	0.55	2.5	4.6	0.74	2.5	4.5	0.32	3.2
7½	6.9	0.82	3.8	6.8	1.10	3.7	6.8	0.47	4.8
10	9.2	1.09	5.0	9.1	1.47	4.9	9.0	0.63	6.4
By-products, etc.	H. O. horse feed, 1 : 6.4			Barley, 1 : 8.0			Barley screenings, 1 : 7.7		
¼	0.2	0.02	0.1	0.2	0.02	0.2	0.2	0.02	0.2
½	0.5	0.05	0.3	0.4	0.04	0.3	0.4	0.04	0.3
1	0.9	0.09	0.6	0.9	0.09	0.7	0.9	0.09	0.7
2	1.8	0.18	1.2	1.8	0.17	1.4	1.8	0.17	1.3
3	2.7	0.28	1.8	2.7	0.26	2.1	2.6	0.26	2.0
4	3.6	0.37	2.4	3.6	0.35	2.8	3.5	0.34	2.7
5	4.5	0.46	2.9	4.5	0 44	3.5	4.4	0.43	3.3
7½	6.8	0.69	4.4	6.7	0.65	5.2	6.6	0.65	5.0
10	9.0	0.92	5.9	8.9	0.87	6.9	8.8	0.86	6.6

TABLE III.—*Continued.*

Pounds of fodder	Total dry matter	Protein	Carbohydrates, etc.	Total dry matter	Protein	Carbohydrates, etc.	Total dry matter	Protein	Carbohydrates, etc.
By-products	Wheat bran, 1 : 3.8			Wheat middlings, 1 : 4.6			Wheat screenings, 1 : 5.2		
¼	0.2	0.03	0.1	0.2	0.03	0.1	0.2	0.02	0.1
½	0.4	0.06	0.2	0.4	0.06	0.3	0.4	0.05	0.2
1	0.9	0.12	0.5	0.9	0.13	0.6	0.9	0.10	0.5
2	1.8	0.24	1.0	1.8	0.25	1.2	1.8	0.20	1.0
3	2.6	0.36	1.4	2.6	0.38	1.7	2.7	0.29	1.5
4	3.5	0.48	1.8	3.5	0.50	2.3	3.5	0.39	2.0
5	4.4	0.60	2.3	4.4	0.63	2.9	4.4	0.49	2.5
7½	6.6	0.90	3.4	6.6	0.94	4.4	6.6	0.74	3.8
10	8.8	1.20	4.6	8.8	1.25	5.8	8.8	0.98	5.1
By-products, etc.	Mixed (wheat) feed, 1 : 3.9			Red dog flour, 1 : 3.3			Rye, 1 : 7.8		
¼	0.2	0.03	0.1	0.2	0.04	0.1	0.2	0.02	0.2
½	0.4	0.07	0.3	0.5	0.09	0.3	0.4	0.04	0.3
1	0.9	0.13	0.5	0.9	0.18	0.6	0.9	0.09	0.7
2	1.8	0.27	1.0	1.8	0.36	1.2	1.8	0.18	1.4
3	2.7	0.40	1.5	2.7	0.53	1.7	2.7	0.27	2.1
4	3.6	0.53	2.1	3.6	0.71	2.3	3.5	0.36	2.8
5	4.5	0.67	2.6	4.6	0.89	2.9	4.4	0.46	3.5
7½	6.7	1.00	3.8	6.8	1.34	4.4	6.6	0.67	5.2
10	8.9	1.33	5.2	9.1	1.78	5.8	8.8	0.89	6.9
By-products	Rye bran, 1 : 5.1			Cottonseed meal, 1 : 1.0			Cottonseed feed, 1 : 5.6		
¼	0.2	0.03	0.2	0.2	0.10	0.1	0.2	0.02	0.1
½	0.4	0.06	0.3	0.5	0.20	0.2	0.4	0.04	0.2
1	0.9	0.12	0.6	0.9	0.40	0.4	0.9	0.08	0.4
2	1.8	0.25	1.3	1.8	0.80	0.8	1.8	0.16	0.9
3	2.7	0.37	1.9	2.8	1.20	1.2	2.7	0.24	1.3
4	3.5	0.49	2.5	3.7	1.60	1.6	3.5	0.32	1.8
5	4.4	0.62	3.1	4.6	2.00	2.0	4.4	0.40	2.2
7½	6.6	0.92	4.7	6.9	3.00	3.0	6.6	0.59	3.3
10	8.8	1.23	6.3	9.2	4.00	4.0	8.8	0.79	4.4
By-products	Cottonseed hulls, ——			Linseed meal (O. P.), 1 : 1.5			Linseed meal (N. P.), 1 : 1.3		
¼	0.2	....	0.1	0.2	0.08	0.1	0.2	0.08	0.1
½	0.4	....	0.2	0.5	0.15	0.2	0.4	0.16	0.2
1	0.9	....	0.4	0.9	0.31	0.5	0.9	0.32	0.4
2	1.8	....	0.7	1.8	0.62	1.0	1.8	0.65	0.8
3	2.7	....	1.1	2.7	0.92	1.4	2.7	0.97	1.3
4	3.6	....	1.5	3.6	1.23	1.8	3.6	1.30	1.7
5	4.5	....	1.8	4.9	1.54	2.3	4.5	1.62	2.1
7½	6.7	....	2.7	6.8	2.31	3.4	6.7	2.43	3.2
10	8.9	....	3.7	9.0	3.08	4.6	8.9	3.24	4.2

TABLE III.—*Continued.*

Pounds of fodder	Total dry matter	Protein	Carbohydrates, etc.	Total dry matter	Protein	Carbohydrates, etc.	Total dry matter	Protein	Carbohydrates, etc.
By-products	Flax meal, 1 : 1.4			Gluten meal (Chicago) 1 : 1.5			Gluten meal (Cream) 1 : 1.7		
¼	0.2	0.08	0.1	0.2	0.08	0.1	0.2	0.07	0.1
½	0.4	0.16	0.2	0.4	0.16	0.2	0.4	0.15	0.2
1	0.9	0.32	0.4	0.9	0.32	0.5	0.9	0.30	0.5
2	1.8	0.64	0.9	1.8	0.64	0.9	1.8	0.59	1.0
3	2.7	0.96	1.3	2.6	0.96	1.4	2.7	0.89	1.5
4	3.6	1.28	1.7	3.5	1.28	1.9	3.6	1.19	2.1
5	4.5	1.60	2.2	4.4	1.60	2.3	4.5	1.49	2.6
7½	6.7	2.40	3.3	6.6	2.40	3.5	6.7	2.23	3.9
10	8.9	3.21	4.3	8.8	3.21	4.7	9.0	2.97	5.1
By-products	Gluten meal (King) 1 : 1.9			Gluten feed (Buffalo or Marshalltown) 1 : 2.4			Gluten feed (Diamond or Rockford) 1 · 3.0		
¼	0.2	0.07	0.1	0.2	0.06	0.1	0.2	0.05	0.2
½	0.5	0.15	0.3	0.4	0.12	0.3	0.5	0.10	0.3
1	0.9	0.30	0.6	0.9	0.23	0.6	0.9	0.20	0.6
2	1.9	0.59	1.1	1.8	0.47	1.1	1.8	0.41	1.2
3	2.8	0.89	1.7	2.7	0.70	1.7	2.7	0.61	1.9
4	3.7	1.19	2.3	3.6	0.93	2.3	3.6	0.81	2.5
5	4.6	1.49	2.8	4.5	1.17	2.8	4.6	1.02	3.1
7½	6.9	2.23	4.3	6.8	1.75	4.3	6.8	1.52	4.7
10	9.3	2.97	5.7	9.0	2.33	5.7	9.1	2.03	6.2
By-products	Hominy chop, 1 : 9.2			Starch feed wet, 1 : 4.9			Dried brewers' grains, 1 : 3.0		
¼	0.2	0.02	0.2	0.1	0.01	0.1	0.2	0.04	0.1
½	0.5	0.04	0.4	0.2	0.03	0.2	0.5	0.08	0.3
1	0.9	0.09	0.8	0.3	0.05	0.3	0.9	0.16	0.5
2	1.8	0.17	1.6	0.7	0.11	0.5	1.8	0.31	0.9
3	2.8	0.26	2.4	1.0	0.16	0.8	2.8	0.47	1.4
4	3.7	0.35	3.2	1.4	0.22	1.1	3.7	0.63	1.9
5	4.6	0.44	4.0	1.7	0.27	1.3	4.6	0.79	2.4
7½	6.9	0.65	6.0	2.6	0.41	1.7	6.9	1.18	3.5
10	9.2	0.87	8.0	3.5	0.54	2.6	9.2	1.57	4.7
By-products	Atlas gluten meal, 1 : 2.6			Malt sprouts, 1 : 2.2			Pea meal, 1 : 3.2		
¼	0.2	0.06	0.2	0.2	0.05	0.1	0.2	0.04	0.1
½	0.5	0.12	0.3	0.4	0.09	0.2	0.4	0.08	0.3
1	0.9	0.25	0.6	0.9	0.19	0.4	0.9	0.17	0.5
2	1.8	0.49	1.3	1.8	0.37	0.8	1.8	0.33	1.1
3	2.8	0.74	1.9	2.7	0.56	1.2	2.7	0.50	1.6
4	3.7	0.98	2.6	3.6	0.74	1.6	3.6	0.67	2.1
5	4.6	1.23	3.2	4.5	0.93	2.0	4.5	0.84	2.7
7½	6.9	1.85	4.9	6.7	1.40	3.0	6.7	1.26	4.0
10	9.2	2.46	6.5	9.0	1.86	4.0	9.0	1.68	5.3

TABLE IV.—MANURIAL CONSTITUENTS IN 1,000 POUNDS MANURES, FERTILIZERS, STRAW, BEDDING MATERIALS, FOOD STUFFS, ETC.

REFERENCES.—The numbers given in the first column in the tables following designate the authorities from which the analyses are taken as per the key below:—

1. Hatch Experiment Station Reports, Amherst, Mass. 2. *Wolff-Lehman, Kalender von O. Mentzel und A. v. Lengerke* 1900, I. *Teil.* 3. Yearbook of the Department of Agriculture, 1894. 4. Rocks and Soils, Stockbridge. 5. The Fertility of the Land, Roberts.

	Authority.	Water. Pounds.	Ash. Pounds.	Nitrogen. Pounds.	Potash. Pounds.	Phosphoric Acid. Pounds.
MANURES AND FERTILIZERS.						
Animal Excrements, Etc.:—						
Barnyard manure	1	672.4	—	5.2	5.6	3.9
Drainage from manure heap	1	932.0	36.6	9.8	8.8	2.4
Goose manure	1	489.2	—	2.1	8.1	9.5
Hen manure, fresh	1	523.5	247.5	9.9	2.5	7.4
Henhouse refuse	1	73.7	—	7.1	10.3	10.2
Hen manure with kainite	1	415.8	—	13.0	29.6	12.1
Hen manure without kainite	1	96.6	—	18.3	14.8	39.3
Horse manure	1	112.4	—	7.4	28.2	14.6
Poudrette, dry	1	52.5	354.5	35.8	4.9	57.4
Sheep manure	1	292.2	—	14.4	11.7	9.2
Sea Manures:—						
Eel grass	1	353.9	156.0	8.3	9.1	3.2
Rock weed, green	1	685.0	237.0	6.2	—	—
Rock weed, dry	1	106.8	357.5	14.5	48.9	27.5
Guanos, Phosphates, Etc.:—						
Acid phosphate	1	142.3	699.5	—	—	146.4
Bat guano from Florida	1	156.6	—	97.4	17.7	33.5
Bat guano from Texas	1	400.9	182.4	64.7	13.1	37.6
Boneblack	1	46.0	—	—	—	282.8
Cuban guano	1	242.7	—	16.7	—	133.5
Dissolved boneblack	1	101.7	475.0	—	—	162.5
Double superphosphate	1	57.4	—	—	—	478.0
Florida rock phosphate	1	20.0	—	—	2.1	260.2
Mona Island guano	1	133.2	—	7.6	—	218.8
Odorless phosphate	1	29.9	—	—	3.8	195.4
Peruvian guano	1	148.1	376.1	78.5	26.1	152.6
Phosphatic slag	1	14.5	—	—	—	234.9
Soft Florida phosphate	1	48.7	—	—	—	187.3
South American bone ash	1	70.0	—	—	—	358.9
South Carolina floats	1	8.3	—	—	—	233.9
S. C. rock phosphate	1	13.6	—	—	—	274.2
Chemicals, Refuse Substances, Ashes, Etc.:—						
Apatite	1	—	—	—	—	326.2
Ashes of spent tan bark	1	48.4	—	—	18.1	13.6
Ashes from cremation of swill	1	48.6	—	—	39.7	141.6
Bituminous coal ashes	1	36.6	—	—	3.8	4.4
Carbonate of potash	1	268.8	—	—	184.8	—
Corn-cob ashes	1	12.0	—	—	70.8	23.7
Cottonseed hull ashes	1	86.0	—	—	225.5	85.9
Kainite	1	31.8	—	—	135.6	—

TABLE IV.—*Continued.*

	Authority.	Water. Pounds.	Ash. Pounds.	Nitrogen. Pounds.	Potash. Pounds.	Phosphoric Acid. Pounds.
MANURES AND FERTILIZERS—*Continued.*						
Chemicals, Refuse Substances, Ashes, Etc.:—						
Lime-kiln ashes	1	144.8	—	—	12.8	10.9
Lime waste from sugar factory	1	363.0	—	—	2.2	22.5
Marls (Virginian)	1	159.8	—	—	4.9	.9
Marls (Massachusetts)	1	137.0	—	—	2.4	10.5
Muriate of potash	1	17.7	—	—	510.0	—
Nitrate of potash	1	13.0	—	127.1	452.7	—
Nitrate of soda	1	13.8	—	150.4	—	—
Peat ashes	1	46.7	—	—	4.6	1.1
Phosphate of ammonia	1	60.5	—	103.7	—	438.6
Phosphate of potash	1	37.6	—	—	325.6	375.0
Railroad tie ashes	1	47.0	—	—	9.2	5.6
Seaweed ashes	1	14.7	—	—	9.2	3.0
Silicate of potash	1	21.7	—	2.5	276.2	—
Sulfate of potash	1	18.6	—	—	402.1	—
Sulfate of potash-magnesia	1	48.1	—	—	248.2	—
Sulfate of ammonia	1	10.6	—	220.3	—	—
Wood ashes	1	103.8	—	—	53.9	15.1
Refuse Substances:—						
Ammonite	1	58.8	—	113.3	—	34.3
Blood and bone	1	83.6	—	67.4	—	110.1
Bones	1	67.6	530.3	38.7	—	224.3
Castor bean pomace	1	96.8	57.0	55.1	15.7	21.8
Cottonseed meal	1	70.5	57.8	66.0	17.6	17.9
Dried blood	1	114.3	63.7	104.3	—	26.4
Fish with less than 20% water	1	121.8	215.0	75.8	—	84.8
Fish with between 20 and 40% water	1	301.9	205.9	59.7	—	70.9
Fish with more than 40% water	1	454.6	155.0	49.7	—	50.8
Fresh water mud	1	403.7	—	13.7	2.2	2.6
Hair waste	1	728.1	—	13.9	3.2	6.1
Hop refuse	1	89.8	—	9.8	1.1	2 0
Horn and hoof waste	1	101.7	76.3	132.5	—	18.3
Horn shavings	1	48.3	—	153.1	—	4.2
Chaff, Hulls, and Shells:—						
Barley	2	143.0	71.2	6.4	4.5	1.3
Beans (Field)	2	150.0	54.7	16.8	35.5	2.7
Beans (Soy)	5	120.0	81.0	10.1	9.7	1.7
Corn cobs	1	121.0	—	5.0	6.0	0.6
Millet	5	112.0	112.0	7.7	—	—
Oats	2	143.0	71.2	6.4	4.5	1.3
Peas	5	130.0	58.8	17.4	9.5	1.7
Rye	5	143.0	82.7	5.8	5.2	5.6
Vetch or tare	5	143.0	87.8	14.9	35.1	2.7
Wheat	5	80.5	71.8	7.9	4.2	7.0
Wheat (winter)	2	143.0	92.0	7.2	8.4	4.0

TABLE IV.—*Continued.*

	Authority.	Water. Pounds.	Ash. Pounds.	Nitrogen. Pounds.	Potash. Pounds.	Phosphoric Acid. Pounds.
MANURES AND FERTILIZERS—*Continued.*						
Leaves, Etc., of Vegetables:—						
Artichoke (Jerusalem)	2	800.0	14.5	5.3	3.1	0.7
Beet (common)	2	884.0	19.6	3.4	2.8	2.0
Beet (sugar)	2	897.0	15.3	3.0	4.0	0.7
Cabbage	2	890.0	15.6	2.4	5.8	1.4
Cabbage stems	5	820.0	11.6	1.8	5.1	2.4
Carrots	2	822.0	23.9	5.1	2.9	1.0
Corn husks	5	861.9	5.6	1.8	2.2	0.7
Corn stalks	5	808.6	12.5	2.8	4.1	1.4
Mangel-wurzel	2	905.0	14.6	3.0	4.5	1.0
Potato shortly before harvest	2	770.0	19.7	4.9	4.3	1.6
Turnip	2	898.0	11.9	3.0	2.8	0.9
Ivory dust	1	115.0	526.3	66.4	—	245.6
Linseed meal	1	84.3	—	63.4	12.5	18.4
Lobster shells	1	72.7	—	45.0	—	35.2
Meat and bone	1	52.6	—	45.7	—	202.1
Mill sweepings	1	94.9	—	37.6	6.6	11.8
Muck	1	616.9	137.5	7.9	—	1.3
Mussel mud (wet)	1	600.1	272.9	2.1	61.7	1.0
Mussel mud (dry)	1	22.4	720.2	7.2	—	3.5
Oleomargarine refuse	1	85.4	144.2	121.2	—	8.8
Pine-barren grass	1	84.8	24.0	1.6	0.7	1.8
Pine needles	1	94.8	34.2	4.6	0.3	1.2
Peat (wet)	1	613.6	76.6	8.5	1.8	0.9
Peat (dry)	1	146.7	172.6	18.9	0.6	0.3
Raw wool	1	69.5	75.4	128.8	—	—
Sludge from sewage precipitating tanks	1	884.9	95.0	0.5	0.5	1.0
Sludge	1	62.8	—	6.8	—	13.6
Soot	1	42.9	771.0	4.1	6.3	11.3
Tankage and blood	1	144.3	—	58.8	—	68.4
Tankage	1	82.0	—	61.4	—	128.4
Tobacco leaf	1	130.5	210.1	27.5	72.4	4.3
Tobacco stems	1	106.1	140.7	23.0	70.3	6.2
Turf	1	192.9	63.6	19.4	—	—
Wool waste	1	117.7	241.0	45.6	16.8	3.1
STRAW, BEDDING MATERIALS, ETC.						
Straw:—						
Barley	5	114.4	53.0	13.1	20.9	3.0
Beans (field)	2	160.0	44.9	16.3	19.4	2.9
Beans (soy)	3	130.0	—	17.5	13.2	4.0
Lupine	2	160.0	42.6	9.4	17.7	2.5
Oats	3	90.9	47.6	6.2	12.4	2.0
Pea	2	160.0	43.1	10.4	9.9	3.5
Rye	3	76.1	32.5	4.6	7.9	2.8
Speltz	5	150.0	58.1	4.3	5.2	2.5
Vetch	2	160.0	44.1	12.0	6.3	2.7
Wheat	3	125.6	38.1	5.9	5.1	1.2

TABLE IV.—*Continued.*

	Authority.	Water. Pounds.	Ash. Pounds.	Nitrogen. Pounds.	Potash. Pounds.	Phosphoric Acid. Pounds.
STRAW, BEDDING MATERIALS, ETC.—*Continued.*						
Bedding Materials:—						
Beech leaves (August)	2	560.0	21.6	13.0	4.4	1.8
Fir needles	2	126.0	40.3	9.0	1.3	2.0
Larch needles	2	140.0	34.3	—	1.6	1.3
Moss	2	250.0	20.6	10.5	3.4	1.6
Oak leaves	2	560.0	21.6	13.0	4.4	1.8
Pine needles	2	132.0	32.8	—	2.7	2.7
Reeds	2	140.0	60.0	—	20.2	4.2
Rush	2	180.0	33.5	—	6.0	1.8
Seaweed	2	150.0	146.7	16.4	17.7	4.2
Sedges	5	140.0	16.2	—	17.7	4.6
FOOD STUFFS.						
Green Fodders:—						
Alfalfa	2	740.0	19.2	7.2	4.5	1.6
Alsike clover (in flower)	2	820.0	8.6	5.3	2.4	0.9
Barnyard millet, Japanese	1	750.0	—	4.6	4.9	1.1
Bokhara or sweet clover	1	790.0	—	4.5	4.2	1.3
Corn ensilage	1	800.0	—	4.2	3.9	1.3
Corn and Soy bean ensilage	1	710.0	—	7.9	4.4	4.2
Corn fodder	1	790.0	—	4.1	3.3	1.5
Common buckwheat	1	850.0	—	4.4	5.4	0.9
Cow pea	1	820.0	—	3.2	1.8	1.0
Flat pea	1	790.0	—	10.5	4.5	1.4
Green oats	1	830.0	—	4.9	3.8	1.3
Green rye	1	720.0	—	3.0	6.4	1.2
Horse bean	1	750.0	—	6.8	3.5	0.8
Hungarian grass	1	740.0	—	3.9	5.4	1.6
Japanese millet, Foxtail	1	630.0	—	6.1	4.1	1.9
Japanese buckwheat	1	850.0	—	2.6	5.3	1.4
Kidney vetch	1	810.0	—	5.6	3.5	0.9
Lupine	2	850.0	6.2	5.0	1.5	1.1
Maize	2	829.0	10.4	1.9	3.7	1.0
Millet ensilage	1	740.0	—	2.6	6.2	1.4
Millet and Soy bean ensilage	1	760.0	—	4.8	5.0	1.2
Mixed grasses	2	750.0	15.1	4.4	2.4	1.1
Prickly comfrey	1	870.0	—	3.7	7.6	1.2
Rape	2	870.0	10.5	4.6	3.5	1.2
Red clover (very young)	2	860.0	14.0	6.0	5.1	1.7
Red clover (in bud)	2	820.0	14.7	5.3	5.5	1.5
Red clover (in flower)	2	800.0	13.7	4.8	4.4	1.3
Sorghum	1	830.0	—	2.3	2.3	0.9
Summer rape	1	860.0	—	3.2	7.3	0.9
Small pea	1	820.0	—	4.8	3.7	1.1
Soy bean (Early White)	1	670.0	—	9.4	9.1	2.1
Soy bean (Medium Green)	1	700.0	—	8.4	7.1	2.0

TABLE IV.—*Continued.*

	Authority.	Water. Pounds.	Ash. Pounds.	Nitrogen. Pounds.	Potash. Pounds.	Phosphoric Acid. Pounds.
FOOD STUFFS—*Continued.*						
Green Fodders:—						
Soy bean (late)	1	800.0	—	6.0	6.8	1.4
Serradella	1	830.0	—	4.1	4.2	1.4
Spring vetch	1	850.0	—	3.6	4.5	1.0
Silver-hull buckwheat	1	850.0	—	2.9	3.9	1.4
Vetch and oats	1	860.0	—	2.4	7.9	0.9
White clover (in flower)	2	820.0	8.6	5.3	2.4	0.9
Hay and Dry Coarse Fodders:—						
Alfalfa	1	170.0	—	18.7	13.2	4.8
Alsike clover	1	150.0	—	22.6	21.0	6.3
Barley straw	1	150.0	—	9.5	20.3	1.9
Carrot tops	1	150.0	—	29.5	46.0	5.7
English hay	1	150.0	—	12.7	15.0	2.9
Hungarian grass	3	76.9	—	12.0	13.0	3.5
Italian rye grass	1	150.0	—	11.1	11.8	5.2
Kentucky blue grass	1	150.0	—	11.9	15.2	3.9
Mammoth red clover	1	150.0	—	21.4	11.6	5.2
Meadow hay	2	143.0	—	15.5	16.0	4.3
Meadow fescue	1	150.0	—	9.2	19.6	3.7
Medium red clover	1	150.0	—	20.1	21.1	4.1
Millet	1	150.0	—	12.2	16.1	4.6
Millet straw	1	150.0	—	6.8	17.3	1.8
Orchard grass	1	150.0	—	12.2	15.8	3.8
Perennial rye grass	1	150.0	—	15.5	14.5	5.2
Redtop	1	150.0	—	10.6	9.4	3.3
Rowen	1	150.0	—	17.0	15.6	4.6
Sainfoin	1	150.0	—	25.4	19.5	7.3
Salt hay	1	150.0	—	10.6	6.5	2.3
Soy bean straw	1	150.0	—	6.9	10.4	2.5
Spanish moss	1	150.0	—	6.1	5.6	0.7
Sulla	1	150.0	—	23.1	19.6	4.2
Teosinte	1	150.0	—	13.2	33.5	1.6
Timothy	1	150.0	—	11.9	14.0	3.3
Vetch and oats	1	150.0	—	12.3	12.7	6.2
White daisy	1	150.0	—	2.6	11.8	4.1
White lupine	1	150.0	—	25.6	14.6	2.9
Yellow lupine	1	150.0	—	22.8	25.1	5.1
Vegetables and Roots:—						
Cabbage	3	905.2	14.0	3.8	4.3	1.1
Carrot	1	890.0	—	1.6	4.6	0.9
Onion	3	875.5	5.7	1.4	1.0	0.4
Parsnip	1	800.0	—	2.2	6.2	1.9
Pumpkin	3	922.7	6.3	1.1	0.9	1.6
Sweet potatoes	3	729.6	9.5	2.3	5.0	1.0
Turnip	1	900.0	—	1.7	3.8	1.2

TABLE IV.—*Continued.*

	Authority.	Water. Pounds.	Ash. Pounds.	Nitrogen. Pounds.	Potash. Pounds.	Phosphoric Acid. Pounds.
FOOD STUFFS—*Continued.*						
Vegetables and Roots:—						
Jerusalem artichoke	1	780.0	—	4.6	4.8	1.7
Beet (yellow fodder)	1	910.0	—	1.9	4.6	0.9
Beet (sugar)	1	870.0	—	2.2	4.8	1.0
Ruta-bagas	1	890.0	—	1.9	4.9	1.2
Mangel-wurzel	1	880.0	—	1.5	3.4	1.4
Potatoes	1	800.0	—	2.9	5.1	0.8
Seeds and Seed-like Fruits:—						
Barley	2	145.0	17.0	16.0	2.8	5.6
Buckwheat	2	140.0	11.8	14.4	2.7	5.7
Field beans	2	145.0	31.0	40.8	12.9	12.1
Indian corn	4	144.0	12.4	16.0	3.7	5.7
Linseed	2	118.0	32.6	32.8	10.0	13.5
Lupine (yellow)	5	140.0	38.1	61.2	11.3	14.1
Lupine (blue)	5	140.0	29.0	47.2	11.2	13.8
Lupine (white)	5	140.0	30.4	47.3	11.2	13.8
Millet (broom corn)	2	140.0	29.5	20.3	3.3	6.5
Millet (barnyard)	5	136.8	—	17.3	3.8	6.9
Millet (foxtail)	5	124.0	33.0	16.0	—	—
Oats	1	90.0	—	21.0	—	—
Peas	2	143.0	23.4	35.8	10.1	8.4
Rye	2	143.0	17.9	17.6	5.8	8.5
Sorghum	2	140.0	16.0	—	3.3	8.1
Soy beans	1	183.0	—	53.0	19.9	18.7
Speltz	4	148.0	36.6	16.0	5.8	7.6
Vetch	2	143.0	26.6	44.0	8.0	9.9
Wheat	2	144.0	16.8	20.8	5.2	7.9
Mill Products:—						
Apple pomace	3	805.0	2.7	2.3	1.3	0.2
Barley flour	2	105.0	20.0	16.0	5.8	9.5
Barley bran	2	120.0	49.5	17.6	8.3	10.8
Barley middlings	2	130.0	21.1	—	5.5	9.1
Barley ground	3	134.3	20.6	15.5	3.4	6.6
Brewers' grains (dried)	3	91.4	39.2	36.2	0.9	10.3
Brewers' grains (wet)	3	750.1	—	8.9	0.5	3.1
Buckwheat bran (coarse)	5	156.0	28.0	12.8	0.5	4.2
Buckwheat bran (fine)	2	140.0	29.8	27.2	9.7	10.7
Buckwheat middlings (coarse)	5	120.0	47.0	50.8	11.4	12.3
Buckwheat middlings (fine)	5	147.0	14.0	13.8	3.4	6.8
Buckwheat hulls	1	119.0	—	4.9	5.2	0.7
Corn cobs	1	121.0	—	5.0	6.0	0.6
Corn meal	1	141.0	—	19.2	3.4	7.1
Corn and cob meal	1	90.0	—	14.1	4.7	5.7
Corn middlings (coarse)	5	130.0	19.4	13.6	2.6	4.4
Corn middlings (fine)	5	152.0	14.0	15.1	1.7	3.0

TABLE IV.—*Continued.*

	Authority.	Water. Pounds.	Ash. Pounds.	Nitrogen. Pounds.	Potash. Pounds.	Phosphoric Acid. Pounds.
FOOD STUFFS—*Continued.*						
Mill Products:—						
Corn sprouts cake	5	114.3	19.2	26.5	5.0	8.0
Cottonseed cake from unshelled seed	5	118.6	63.8	38.8	25.8	16.1
Cottonseed cake from shelled seed	5	86.5	70.4	70.6	15.8	32.5
Cottonseed cake	2	112.0	66.4	62.1	15.8	30.5
Cottonseed hulls	1	106.0	—	7.5	10.8	1.8
Cottonseed meal	1	82.0	—	67.0	18.3	24.7
Gluten meal	1	85.0	—	50.9	0.5	4.2
Hominy feed	3	89.3	22.1	16.3	4.9	9.8
Hops (after brewing)	5	109.4	64.0	24.5	4.6	10.8
Hops (spent)	5	755.0	—	10.8	4.0	3.2
Lentil middlings	5	134.0	24.0	41.3	6.5	7.8
Linseed cake	2	122.0	51.3	47.2	12.5	16.2
Linseed meal, O. P.	1	80.0	—	53.9	12.1	17.8
Linseed meal, N. P.	1	80.0	—	58.3	12.5	17.0
Malt, barley (green)	2	475.0	14.6	10.4	2.5	5.3
Malt, barley (dry)	2	75.0	25.6	16.0	4.4	9.3
Malt sprouts (barley)	3	183.8	124.8	35.5	16.3	14.3
Malt sprouts (corn)	5	150.0	63.0	46.6	18.7	16.2
Mash, wheat (fresh)	5	890.5	4.2	3.5	1.3	1.9
Mash, wheat (dry)	5	120.0	87.0	45.9	27.0	40.9
Mash, rye (fresh)	5	922.0	4.1	2.7	1.2	1.8
Mash, rye (dry)	5	106.0	73.0	37.0	22.4	33.5
Mash, corn (fresh)	5	913.2	4.6	3.2	12.2	19.5
Mash, corn (dry)	5	94.0	44.2	37.1	12.7	20.4
Mash, potato	2	930.0	6.6	1.6	3.0	1.3
Middlings, mixed (best quality)	5	128.0	33.0	22.6	9.6	12.2
Millet bran	5	106.0	115.0	7.0	12.5	15.2
Millet middlings	5	111.0	49.0	18.6	21.1	8.9
Molasses slump	5	920.0	14.0	3.2	11.0	0.1
Oats, ground	3	111.7	33.7	18.6	5.9	7.7
Oat bran	5	110.0	82.8	13.4	7.1	2.2
Oat middlings (fine)	5	100.0	52.0	26.1	15.3	27.0
Oat middlings (coarse)	5	100.0	62.0	18.7	15.3	22.5
Oat hulls	5	140.0	34.7	—	4.9	1.6
Pea bran	5	140.0	22.7	—	10.3	3.1
Pea meal	1	89.0	—	30.8	9.9	8.2
Pea hulls	5	125.0	37.0	22.4	10.0	8.8
Pea middlings	5	135.0	31.0	37.4	7.8	6.5
Peanut cake	2	104.0	39.7	75.6	15.0	13.1
Potato slump	5	948.0	5.0	1.6	22.0	1.0
Rape cake	2	113.0	57.0	50.5	13.0	20.0
Rice bran	3	102.0	129.4	7.1	2.4	2.9
Rice middlings	2	100.0	54.7	19.1	6.1	23.8
Rice polish	3	103.0	90.0	19.7	7.1	26.7
Rye flour	3	142.0	—	16.8	6.5	8.5
Rye bran	3	125.0	46.0	23.2	14.0	22.8
Rye middlings	1	125.0	—	18.4	8.1	12.6

TABLE IV.—*Continued.*

	Authority.	Water. Pounds.	Ash. Pounds.	Nitrogen. Pounds.	Potash. Pounds.	Phosphoric Acid. Pounds.
FOOD STUFFS—*Continued.*						
Mill Products:—						
Soy bean cake	5	125.9	53.5	66.2	18.0	22.0
Sugar beets (diffused cuttings)	2	948.0	3.3	0.8	0.3	0.2
Sugar beet molasses	2	172.0	82.6	12.8	8.7	0.5
Sunflower seed cake	2	103.0	49.7	59.7	11.7	21.5
Starch feed, glucose refuse	3	81.0	—	26.2	1.5	2.9
Wheat flour	1	121.0	—	20.2	3.6	3.5
Wheat bran	1	99.0	—	23.6	14.0	21.0
Wheat middlings	1	102.0	—	27.5	7.5	12.5

Table V.—Measurements for Silos.

Giving the inside diameter of silos 24 feet and 30 feet deep which will permit the surface to be lowered in feeding at the mean rate of 1.2 to 2 inches per day, assuming 40 lbs. of silage to be fed to each cow daily.

By courtesy of Wisconsin Experiment Station.

No. of Cows	Feed for 240 Days				Feed for 180 Days			
	Silo 24 feet deep		Silo 30 feet deep		Silo 24 feet deep		Silo 30 feet deep	
	Rate 1.2 in. daily		Rate 1.5 in. daily		Rate 1.6 in. daily		Rate 2 in. daily	
	Tons	Inside diameter	Tons	Inside diameter	Tons	Inside diameter	Tons	Inside diameter
		ft. in.		ft. in.		ft. in.		ft. in.
10	48	11 11	48	10 2	36	10 4	36	8 9
15	72	14 7	72	12 5	34	12 8	54	10 9
20	96	16 10	96	14 4	72	14 7	72	12 5
25	120	18 10	120	16 0	90	16 4	90	13 10
30	144	20 8	144	17 6	108	17 10	108	15 2
35	168	22 4	168	18 11	126	19 4	126	16 4
40	192	23 10	192	20 3	144	20 8	144	17 6
45	216	25 7	216	21 5	162	21 11	162	18 7
50	240	26 8	240	22 7	180	23 1	180	19 7
60	288	29 2	288	24 9	216	25 3	216	21 5
70	336	31 6	336	26 9	252	27 4	252	23 2
80	384	33 8	384	28 7	288	29 2	288	24 9
90	432	35 9	432	30 4	324	30 11	324	26 3
100	480	37 8	480	31 11	360	32 8	360	27 8

TABLE VI.—KEY TO ROTATIONS AND CROPPING PRINCIPAL FIELDS MASSACHUSETTS AGRICULTURAL COLLEGE.

West Field		1898.	Potatoes.
		1899.	Ensilage corn and seeded.
		1900.	Hay.
		1901.	Hay.
North Flat	I.		Yearly, for three years, Japanese barnyard millet followed by celery.
	II.	1898.	Hay.
		1899.	Corn.
		1900.	Potatoes.
		1901.	Japanese barnyard millet.
Hatch Slope		1898.	Potatoes.
		1899.	Ensilage corn and seeded.
		1900.	Hay.
		1901.	Hay.
Experiment Field			Contains about 125 plots and is used in experiments with manures and fertilizers with all kinds of crops.
Cowles Field	I.		Experiment orchard, apples and plums.
	II.		Permanent grass, experiment in manuring.
Old Vineyard			Mostly Concord grapes, set about 1868.
Old Orchard			Largely set about 1870.
Middle Flat	I.		Experiments with alfalfa, lupines, and awnless brome grass.
	II.	1897.	Hay.
		1898.	Hay.
		1899.	Hay.
		1900.	Japanese barnyard millet for seed.
		1901.	Ensilage corn and to be seeded.
	III.		Last three years used for pasturing hogs: crops, dwarf Essex rape, oats and peas; barley and peas, turnips, etc.
South Flat	I.	1899.	Mangels and carrots.
		1900.	Mangels and carrots.
		1901.	Ensilage corn to be seeded.
	II.	1897.	Hay.
		1898.	Hay.
		1899.	Corn and Japanese barnyard millet for seed.
		1900.	Ensilage corn and seeded.
		1901.	Hay.
	III.	1897.	Ensilage corn and seeded.
		1898.	Hay.
		1899.	Hay.
		1900.	Hay.
		1901.	Corn.

Table VI.—*Continued.*

South Flat—Continued	IV.	1897.	Corn.
		1898.	Ensilage corn and seeded.
		1899.	Hay.
		1900.	Hay.
		1901.	Hay followed by cabbages.
	V.	1897.	Corn.
		1898.	Ensilage corn and seeded.
		1899.	Hay.
		1900.	Hay.
		1901.	Night pasture for cows.
	VI.	1897.	Hay.
		1898.	
		1899.	Night pasture for cows.
		1900.	
		1901.	Corn.
Campus Slope	I.	1898.	Hay.
		1899.	Hay.
		1900.	Corn.
		1901.	Potatoes and onions.
	II.	1898.	Hay.
		1899.	Hay.
		1900.	Corn followed by winter rye as cover crop and in part cut and fed, in part plowed in.
		1901.	Ensilage corn and soy beans.
Bangs Field			Permanent Mowing.
Front Slope			Permanent Mowing.
Chester Field			Permanent Mowing.
South Field			Permanent Mowing.
Triangle			Permanent Mowing.
Maynard Lot			Permanent Mowing.
Stockbridge Lot	I.		Raspberries and blackberries, trial of varieties.
	II.		Strawberries, and such garden crops as early sweet corn, tomatoes, early lettuce, early beets, etc., alternate.
Henderson Lot	I.		Vineyard, about 200 varieties grapes.
	II.		Apples, plums, gooseberries; many varieties.
Market Garden			Crops: strawberries, celery, onions, and other garden crops and nursery stock.
Botanic Garden			Is to contain all plants indigenous in Massachusetts.
Clark Orchard			Peaches, apples, and pears; set in 1897.

LIVE STOCK REGISTRY ASSOCIATIONS,

With the Names of the Secretaries or Editors.

Horses.

American Thoroughbred Stud Book, James E. Wheeler, 173 Fifth Ave., New York.
American Hackney Stud Book, Wm. Seward Webb, 51 East 44th St., New York.
Dominion Hackney Stud Book, Henry Wade, Toronto, Ont.
National Register of Morgan Horses, Jos. Battell, Middlebury, Vt.
American Clydesdale Stud Book, Charles F. Mills, Springfield, Ill.
Dominion Clydesdale Stud Book, Henry Wade, Toronto, Ont.
American Shire Horse Association, Charles Burgess, Wenona, Ill.
Dominion Shire Horse Stud Book, Henry Wade, Toronto, Ont.
American Cleveland Bay Stud Book, R. P. Stericker, Springfield, Ill.
American Suffolk Punch Association, Alex. Galbraith, Janesville, Wis.
Percheron Stud Book of America, S. D. Thompson, Wayne, Ill.
American French Coach Horse Society, S. D. Thompson, Wayne, Ill.
National Register of French Draft Horses, C. E. Stubbs, Fairfield, Iowa.
National Register of Norman Horses, Theo. Butterworth, Quincy, Ill.
American Belgian Draft Horse Association, J. D. Conner, Jr., Wabash, Ind.
German Coach Horse Association, J. Crouch, Lafayette, Ind.
Oldenburg Coach Horse Association, C. E. Stubbs, Fairfield, Iowa.
American Trotting Register Association, J. H. Steiner, 355 Dearborn St., Chicago, Ill.
American Saddle Horse Breeders' Association, I. B. Nall, Louisville, Ky.
American Jack Stock Stud Book, J. H. Fullton, Grassland, Tenn.
American Shetland Club Stud Book, Mortimer Levering, Lafayette, Ind.

Cattle.

American Short-Horn Breeders' Association, John W. Groves, Springfield, Ill.
Dominion Short-Horn Herd Book, Henry Wade, Toronto, Ont.
American Polled Durham Herd Book, J. H. Miller, Mexico, Ind.
American Hereford Cattle Breeders' Association, C. R. Thomas, Independence, Mo.
Dominion Hereford Herd Book, Henry Wade, Toronto, Ont.
American Aberdeen-Angus Herd Book, Thos. McFarlane, Harvey, Ill.
Dominion Polled Angus Herd Book, Henry Wade, Toronto, Ont.
American Galloway Breeders' Association, Frank B. Hearne, Independence, Mo.
North American Galloway Herd Book, Henry Wade, Toronto, Ont.
American Jersey Cattle Club Herd Register, J. J. Hemingway, 8 West 17th St., New York.
American Jersey Herd Book, O. B. Hadwen, Worcester, Mass.

Maine State Jersey Cattle Association Herd Book, N. R. Pike, Winthrop, Me.
American Guernsey Cattle Club Herd Register, Wm. H. Caldwell, Peterboro, N. H.
Holstein-Friesian Herd Book, Frederick L. Houghton, Brattleboro, Vt.
Holstein-Friesian Herd Book of Canada, J. W. Clemons, St. George, Ont.
Dutch Belted Herd Book, H. B. Richards, Easton, Pa.
American Branch Association North Holland Herd Book, Fred. H. Beach, Dover, N. J.
Ayrshire Record, C. M. Winslow, Brandon, Vt.
Canadian Ayrshire Herd Book, Henry Wade, Toronto, Ont.
American Devon Record, L. P. Sisson, Wheeling, W. Va.
Swiss Record, N. S. Fish, Groton, Conn.
Red Polled Herd Book, J. McLain Smith, Dayton, O.
American Sussex Association, Overton Lea, Nashville, Tenn.
American Holderness Herd Book, T. A. Cole, Solsville, N. Y.
Kerry Cattle, Henry S. Ambler, Chatham, N. Y.

Sheep.

American Shropshire Sheep Record, Mortimer Levering, Lafayette, Ind.
Flock Record of Hampshire-Down Sheep, Jno. I. Gordon, Mercer, Pa.
American Leicester Record, A. J. Temple, Cameron, Ill.
Flock Record of Dorset Horn Sheep in America, M. A. Cooper, Washington, Pa.
Dorset-Horn Continental Club, J. E. Wing, Mechanicsburg, O.
Flock Book American Cheviot Sheep Breeders' Association, Robert L. Davidson, Cooperstown, N. Y.
National Cheviot Sheep Breeders' Association, H. Keim, Ladoga, Ind.
American Cotswold Record, Geo. Harding & Son, Waukesha, Wis.
American Southdown Record, Jno. J. Springer, Springfield, Ill.
American Oxford Down Record, W. A. Shafor, Middletown, O.
Standard American Merino Sheep Breeders' Association, John P. Ray, Hemlock Lake, N. Y.
Standard Delaine Spanish Merino Sheep Breeders' Association, S. M. Cleaves, East Bethlehem, Pa.
National Merino Sheep Register Association, C. C. Johnson, Cannonsburg, Pa.
Register N. Y. State American Merino Sheep Breeders' Association, J. Horatio Earll, Skaneateles, N. Y.
Register Vermont Merino Sheep Breeders' Association, Lewis A. Skiff, Middlebury, Vt.
Register Michigan Merino Sheep Breeders' Association, E. N. Ball, Hamburg, Mich.
U. S. Merino Sheep Breeders' Registry Association, J. A. B. Walker, Enon Valley, Pa.
Black Top Spanish Merino Sheep Register, W. G. Berry, Houstonville, Pa.
Improved Black Top Merino Association, L. M. Harsh, Union City, Mich.
Standard Delaine Merino Sheep Breeders' Association, Alexander Turnbull, Cedarville, O.
National Delaine Merino Sheep Breeders' Association, John C. McNary, Cannonsburg, Pa.
National Dickinson Record Co., H. G. McDowell, Canton, O.
American Rambouillet Sheep Breeders' Association, E. V. Burnham, Woodstock, O.
Ohio Merino Breeders' Association, Wesley Bishop, Troyton. O.

Vermont Atwood Club Register, Geo. Hammond, Middlebury, Vt.
National Improved Saxony Sheep Breeders' Association, John G. Clark, Toledo, Pa.
National Lincoln Sheep Breeders' Association, H. A. Daniells, Elva, Mich.
American Suffolk Flock Registry Association, Geo. W. Franklin, Atlantic, Iowa.
Dominion Sheep Breeders' Flock Book, Henry Wade, Toronto, Ont.
American Angora Goat Breeders' Association, C. P. Bailey, San José, Cal.

Swine.

American Berkshire Association, Chas. F. Mills, Springfield, Ill.
Central Poland-China Record, W. H. Morris, Indianapolis, Ind.
Standard Poland-China Record, Geo. F. Woodworth, Maryville, Mo.
Ohio Poland-China Record, Carl Freigau, Dayton, O.
National Poland-China Breeders' Association, E. C. Rouse, Albion, Mich.
American Poland-China Record Co., William M. McFadden, West Liberty, Iowa.
Northwestern Poland-China Record Association, J. B. Besack, Washington, Kansas.
National Chester White Record, Carl Freigau, Dayton, O.
Chester White Record Association, W. M. Lambing, West Liberty, Iowa.
Standard Chester White Record Association, W. H. Morris, Indianapolis, Ind.
Todd's Improved Chester White Record, Carl Freigau, Dayton, O.
American Duroc-Jersey Record, A. V. Braderick, Connersville, Ind.
National Duroc-Jersey Record, Robt. J. Evans, El Paso, Ill.
Cheshire Herd Book, B. B. Badger, Ouaquaga, N. Y.
Victoria Swine Record, H. Davis, Dyer, Ind.
Record Improved Essex Swine, F. M. Srout, McLean, Ill.
Small Yorkshire Swine Register, Geo. W. Harris, Box 3432, New York.
American Yorkshire Club, W. F. Wilcox, Minneapolis, Minn.
American Suffolk Association, W. F. Watson, Winchester, Ind.
Tamworth Swine Association, Edwin O. Wood, Flint, Mich.
Gothland Swine Breeders' Association, Grant W. Spear, Aurora, Ill.
Dominion Swine Breeders' Record, Henry Wade, Toronto, Ont.